ENGINEERING NEWS

THE most important piece of railroad construction news of the present week is the confirmation of the report that the St. Paul & Duluth Company intends to build an air line from St. Paul to Omaha at an early date. President FISHER and others have incorporated the Duluth, Twin Cities & Southwestern Railroad Company and have made propositions to several towns along the proposed line for right of way. The preliminary surveys have been made and there seems to be no doubt but that the Managers intend to push construction at once.

THE western approach to the Poughkeepsie bridge is being rapidly completed. Contractors MCINTYRE & BARON have a large force of men employed near this village on the two miles of road bed to be built by the bridge company. This part of the work will be completed on or about April 1. The Poughkeepsie & Southwestern Railroad Company, it is stated, will begin work early in April.

Architect H. W. FABIAN read before the German Technical Society of this city, on February 18, a paper on the "Crumbling Groined Arches of the Assembly Chamber of the New Capitol, at Albany, N. Y." Mr. FABIAN said that in 1881 he had shown that there was a weakness in the ribs of the great vault resulting from a variation in the line of the arch and the line of pressure, a variation so great that failure sooner or later was inevitable. The Capitol architect, Mr. M. L. EIDLITZ, at the time contradicted the assertions of Mr. FABIAN and reported a maximum pressure of 270 lbs. per sq. inch instead of the 400 lbs. claimed by the latter on a basis of uniformly distributed pressure. Mr. FABIAN now claims that under existing conditions there is a maximum pressure of 1,300 lbs., and a maximum tensile strain of 300 lbs. per sq. inch. Mr. FABIAN protests against the substitution of a wooden ceiling for this vault, as this would be inconsistent with the monumental character of the building, and he maintains that a stone arch can be made perfectly safe if constructed upon proper mathematical lines.

THE Rhode Island Assembly has passed an amendment to the charter of the city of Providence, authorizing that city to spend $30,000, in addition to the sums now authorized by law, for putting under ground all electric wires belonging to the city in the close fire districts.

IN Cleveland, O., the telephone, telegraph and electric light companies are vigorously fighting the ordinance proposing to bury all wires in that city. Their plea is that "buried wires are as yet an experiment."

MARCH 15, next, is set as the date for a convention at Denver, Col., to consider the subject of irrigation reservoirs in that State. The convention is to be made up of 5 representatives from each of the 44 water districts of the State. A sub-committee, consisting of R. A. SOUTHWORTH, Dr. B. A. WHEELER and E. S. NETTLETON, are to issue the final call.

THE Chicago *Tribune* gives a brief resumé of a report of the Citizen's Association, which is to be presented to the next General Assembly. This is practically the plan prepared by Engineers HERING and COOLEY for the utilization of the Desplaines river as a sewage outlet for Chicago, already frequently described. The report goes on to state that the proposed discharge, at Joliet, of 600,000 cu. ft. per minute would mean 10 ft. of navigable water throughout the Illinois river, an addition of 20 per cent. at the mouth of the river to the normal low-water flow on the Mississippi to Cairo, and 10 per cent. below Cairo. Regarding the rumored disastrous lowering of Lake Michigan by this diversion of its waters, the report says that at the worst the mean level of Lakes Huron and Michigan would be lowered only 6 ins., and still less on Lake Erie.

Mr. DAVID G. WEEMS, of Baltimore, is the inventor of a new method of rapid transit for newspapers, mails and express matter generally, and the Electro-Automatic Transit Co. has been organized in Baltimore to build a test-line. The device consists of a light elevated structure carrying two lines of rails upon which travels a light car, or train of cars; a third rail above the train serves as a guide rail and a conductor of electricity to a motor on the forward car. Switching, stopping, etc , is done automatically. It is claimed that the distance—801 miles—between Baltimore and Chicago can be covered in two hours, and matter from New York to San Francisco would require 9 hours.

We await the development of this "promising" device; there are question of power, air resistance and weather possibilities that must first be settled by an exhaustive trial before it can be called a commercial success.

AN earthquake shock occurred at Akron, O., Feb. 15. At a small town about 4 miles away, according to the despatches, people were thrown out of bed, and windows and ceilings crumbled, while the earth rocked, the convulsions being preceded by a report as of some heavy explosion. A great fissure in the earth is the only sign left of the strange occurrence. People fled from their houses in terror. Old inhabitants say that twenty-five years ago in the same place a similar shock was felt. It strikes us this account must be slightly exaggerated.

A terrific earthquake occurred on Feb. 19, in the province of Yunnan, China. Two thousand lives are reported to have been lost. The province is in Southwest China just north of Burmah and India.

A NAPHTHA storage reservoir is to be built at Odessa, Russia, at a cost of $1,875,000 into which the oil is to be pumped directly from the special steamers bringing it from Batoum.

IT is announced and not denied that Mayors HEWITT of New York and CHAPIN of Brooklyn are between them maturing a bill to abolish the present Board of 20 Trustees of the Brooklyn bridge, and vest its entire management in a single well salaried expert Commissioner with perhaps two Assistant Commissioners, on the ground that the present system of management is cumbrous and unsatisfactory.

THE Board of Experts appointed to examine and recommend plans for improved terminal arrangements for the bridge have agreed on and signed a report which is to be presented at the next regular meeting of the Board of Trustees, which is on March 13. We hope in our issue of March 10, or earlier, to be able to publish it. Some 17 plans in all, of one kind or another, have been considered. The report is entirely unanimous, and is understood to make decided and emphatic recommendations which provide for a very great increase in the present transporting capacity and means of access to cars and station.

OUR railroad news from the Southern States this week is especially full and important and should be noticed by all interested in Southern railways or railway building.

A NEW Brooklyn elevated railway is proposed from Greenpoint Ferry *via* Myrtle Avenue to the City Hall, and thence to the southern section of the city. It is said that the Kings County Elevated is behind the project, seeking a connection with the Brighton Beach road. The Commission has been appointed.

ONE of the New York Central vestibule trains is to be equipped with the MCELROY system of steam heating, a comparatively new system originated in Albany, N. Y., which seems to have many good points.

A GRIP brake of the form we suggested in a late issue has been brought out in St. Paul, as a result of the late cable car disaster there, and it is stated that it is to be applied to the cars. A rail is laid especially for the brake to act on along side the track, which is gripped with great force if necessary by a special lever. The same result might be attained more simply, however, it would appear, by a brake shank extending down through the grip slot, and acting to grip the latter by proper levers.

THE most serious railroad accident of the week was a collision on the Grand Trunk Railway, near Hamilton, Ont., February 16. A passenger and a freight train met, the former running at considerable speed. Both engines and 2 baggage cars were completely wrecked and several freight cars damaged. Two men were killed and 2 injured. The accident was due to a mistake made by the conductor of the freight.——On February 16 a copper train of 30 cars on the Duluth, South Shore & Atlantic Railway, got out of control of the train men and went down the steep grade at a rapid pace to Marquette. Several cars loaded with timber were derailed.——A train on the Boston & Providence Railroad was derailed at Readville, February 20, by a broken flange on a car wheel——Two cars of a Missouri Pacific train near Chamois, Mo., were destroyed by fire, February 15; the cause was the blowing out of a plug in the Baker heater.

A SINGULAR accident occurred last week on the Old Colony Railroad, near Mansfield, Mass. The door of a switch signal lamp flew open, and the engineer of an approaching train saw a white instead of a red light. As a result the train ran into a siding and damaged several freight cars.

THE following bridge accidents are reported: On February 14, a trestle on the Kanawha & Ohio Railway, near Point Pleasant, Va., gave way while under repair. Two men were killed and 3 injured. ——On February 15 a bridge over Apple river, near Elizabeth, Ill., on the Chicago, St. Paul & Kansas City Railway, was knocked down by a derailed freight car, and several cars went down. One man was killed. The bridge was of iron, 186 ft. span; it cost $36,000, and is a complete wreck.

IT is reported that a quicksand bed recently discovered on the Lake front at Chicago, is assuming alarming proportions. The ground is stated to be sinking slowly and with it the tracks of the Illinois Central and Michigan Central Railroads. Many workmen are trying to keep the tracks level. The tunnel machinery and houses are also stated to be sinking. There are fears that the collapse may extend to the gronnd covered by the immense structures on Michigan Avenue, one block west. The breakwater near the lighthouse sunk for over 100 ft. in one day.

THE Buffalo grade crossing agitation is making no progress very fast. There is much talk and many meetings, but little done. The trouble seems to be that they are falling back on that favorite resort for puzzled people who want to do something and do not know exactly what; agitating for the appointment of a "Commission" to formulate plans. The Commission, if formed, will be composed of the very men who are now moving in the matter. The only rational plan is for the Buffalonians to formulate and agree upon *some* plan, and then move to have a definite plan carried out, does not seem to occur to them.

DURING the week serious floods have occurred in New England and other parts of the country, and considerable damage has been done. Near Palmer, Mass., the fields have been covered with water several feet deep, and large quantities of ice have been piled up on the river banks. Many factories and buildings are badly damaged. Washouts have occurred on the New London Northern R. R. and the Boston & Albany R. R. The Delaware river overflowed in Bordentown, N. J., and the Raritan river at New Brunswick, N. J. The dams of the Fountain Water Co. at West Ansonia, Conn., and the Dwight Co., at Chicopee, Mass., have been carried away. The latter was 320 ft. long and 18 ft. high, and was about 50 years old; the loss is estimated at $40,000. Bridges have been wrecked at Gilbertville, Blanchardville, Palmer and Three Rivers, Mass.; West Ansonia, Conn.; and Dover, N. H. A washout occurred on the Wabash Ry., at Cass, Ind., Feb. 19.

IT is reported that the Ellenville (N. Y.) Glass Sand Co. has succeeded in grinding granite. The plant to do this includes mill-stones weighing 15 tons each. This granite sand is stated to be an excellent substitute for certain glass sands of a much more expensive character.

The Effect of Temperature on the Strength of Railway Axles.

(*Concluded from page 114.*)

GENERAL RECAPITULATION AND REMARKS.

An examination of summary tables affords some tangible results. It would perhaps, however, be unwise, in the present incomplete experimental stage of the temperature impact question, to draw other than limited general conclusions from the indications here afforded; and further experimental observations would be desirable, especially with regard to such higher temperature tests as those of Sets I and II.

First.—The comparative results of the tests, Set I, on axles at the higher temperature of 212° Fahr., compared with axles of this set tested at 7° Fahr., will be seen on reference to the Tables, which indicate an average increase of endurance under impact in these warm tests approaching 235 per cent.; and *vice versa*, a consequent reduced ultimate resistance in the cold tests compared with the warm ones. The ultimate flexibility, under continued impact, judging from the total deflections, at the higher temperature appears to be about 240 per cent. in excess of that at the lower one.

Secondly.—The result of the tests, Set II (in which the axles were submitted to the heavier trial of 1 ton falling 15 ft.), at the temperature of 120° Fahr., compared with results at 7° Fahr., show an average increase of ultimate endurance of impact in favor of these warm tests of near 120 per cent., and the reverse with the cold tests. The ultimate flexibility, under repeated impact, estimated from the total deflections, in this set is about 85 per cent. in favor of the higher temperature.

Thirdly.—The summary tables show that an average total mean force of 261.96 tons was required to effect the destruction of axles in the cold tests of Set III, and an average total mean force of 374.52 tons, to accomplish the same effect in the warm tests (100° Fahr.) of the same set, but under otherwise similar conditions. This comparison, therefore, of the relative strength of the axles in the warm tests (100° Fahr.) and the cold tests (7° Fahr.) gives a general average increase of ultimate resisting power in favor of the former of about 43 per cent., and a consequent similar decrease of strength in the cold tests under the conditions recorded. The ultimate flexibility under impact, taken from the total deflections in this instance, was near 31 per cent. greater in the warm than in the cold tests. The half-axles, tested respectively warm and cold in each set, confirmed the general principle.

TABLE I.

Summary of Cold Tests.

Axle. No.	Temperature.	No. of Blows.	Total Deflections.	Mean Force Ton.	Approx. Temp. of Nominal Rigidity.
12	10° 7°F.	3	6½	180.33	45° F
12	"	2	5⅝	87.71	47°
Av. Set I.		2⅝	5¾	134.0	——
8	"	2	8¾	89.6	37°
9	"	2	8¾	89.3	37°
18	"	6	16⅞	270.4	46°
Av. Set II.		3⅓	8¾	89.5	——
16	"	9	24⅝	412.2	46°
18	"	3	8¾	134.4	45°
19	"	6	16⅞	266.8	45°
22	"	1	2⅝	46.7	41°
24	"	4	10¾	191.4	46°
26	"	4	10¾	191.4	54°
28	"	4	10	196.	54°
29	"	12	28⅝	618.9	54°
30	"	6	15¾	291.4	54°
Av. Set III.		8⅓	14¾	252.0	——

In all these tables the mean force of each blow in tons was determined by dividing the impact in inch tons by the deflection in inches.

The experiments should perhaps be regarded as of a tentative character. The summary of the results in Sets I, II and III, however, appear generally to indicate that the ultimate power of resistance to continued heavy impact of railway axles proportionately increases with an increase of temperature within the range of the present experiments; and *vice versa*, their power of resistance to continued heavy impact diminishes with reduced temperature. Owing to the comparatively limited number of observations more especially in Sets I and II, the percentage results should not be regarded as specific or absolute data but only as affording general indications.

TABLE II.

Summary of Warm Tests.

Axle. No.	Temperature.	No. of Blows.	Total Deflections.	Total Force to Tons.	Approx. Temp. of Nominal Rigidity.
4	212° F.	5	13	248.5	36°
5	"	7	18½	350.7	36°
7	"	13	28⅞	746.1	36°
Av. Set. I.		8	20.	448.4	——
10	120° F.	3	12¼	138.1	37°
11	"	5	18⅝	255.1	37°
Av. Set II.		4	15¼	196.6	——
14	100° F.	5	12⅞	243.5	48°
17	"	6	17⅞	252.8	46°
20	"	3	8⅝	128.7	40°
21	"	5	12⅝	251.6	40°
23	"	6	14⅜	307.3	41°
25	"	10	24	517.2	54°
27	"	11	25¼	596.3	54°
31	"	8	19⅜	404.0	55°
32	"	12	28⅜	626.9	55°
33	"	9	24	417.9	54.
Av. Set III.		7⅓	18⅜	374.5	——

In Set I. the 1-ton ball fell 10 ft.; in Set II. 15 ft., in Set III. 10 ft., the axle being turned half over after each blow. Supports, 3 ft. 6 ins. apart.

It will be noticed that Nos. 15, 16, 19 and 29 of the cold tests appeared exceptional to the general principle, ensuring a greater total mean force before destruction than the axles in the warm tests of this set. The respective halves therefore of each of these axles were turned down to 4½ inches diameter throughout and again tested, the one half at a temperature of 10 d-g. F., the other at 100 deg. F., but otherwise under the equal conditions employed in case of these axles when whole. Thus again tested, the cold half of No. 15 broke with a total mean force of 201.06 tons, the warm half enduring 321.60 tons. The cold half of No. 16 broke with a total mean force of 184.59 tons, the warm half stood 294.48 tons. The cold half of No. 19 fractured with a total mean force of 162.99 tons, the warm half requiring 191.42 tons. The cold half of No. 29 gave way with a total mean force of 54.33 tons, the warm half standing 211.72 tons. From this it will be seen that the results were confirmatory of the rule; the apparent deviation from the general uniformity was possibly due to some molecular difference in the material composing the several axles.

In addition to the above experiments, four small hammered wrought-iron shafts 4½ ins. in diameter, 9 ft. long, were tested by a weight of 1 ton falling 10 ft. equal an "energy" of 22,400 ft.-lbs. for each blow, two at a temperature of 0 deg. F., and the other two at a temperature of 100 deg. F. The two cold shafts endured an average total mean force of 113.37 tons previous to fracture, the warm ones required a total mean force of 194.86 tons to produce breakage.

TABLE III.

Summary of the Effect of Each Blow.

Averages of Sets I., II., III.

No. of Blow.	Set I. Cold Tests Deflection. ins.	Set I. Cold Tests Mean force. Tons	Set I. Warm Tests Deflection. ins.	Set I. Warm Tests Mean force. Tons	Set II. Cold Tests Deflection. ins.	Set II. Cold Tests Mean force. Tons	Set II. Warm Tests Deflection. ins.	Set II. Warm Tests Mean force Tons	Set III. Cold Tests Deflection. ins.	Set III. Cold Tests Mean force. Tons	Set III. rm Tests Deflection. ins.	Set III. rm Tests Mean force. Tons
1	2¼	55.8	3.79	32.7	3.94	4.67	4.56	40.5	2.61	47.0	2.90	42.4
2	2⅝	47.7	2.96	41.6	4.31	42.7	4.00	46.0	2.78	44.5	2.90	42.4
3	2	61.0	2.29	53.5			3.80	52.4	2.56	48.0	2.56	48.1
4			2.25	54.4			3.37	54.3	2.69	46.0	2.51	49.4
5			2.29	54.9			3.00	61.0	2.52	48.8	2.33	52.6
6			2.00	61.0					2.40	52.0	2.39	51.4
7			1.94	63.0					2.50	49.5	2.12	57.8
8			2.00	61.0					2.56	48.5	2.12	57.8
9			1.87	65.0					2.62	47.1	2.44	51.9
10			1.87	65.0					2.37	51.5	2.17	56.6
11			1.87	65.0					2.37	51.5	2.00	61.0
12			1.87	65.0					2.37	51.5	2.00	61.0
13			1.87	65.0								
Total.	5⅝	134.0	20.0	448.4	8.25	89.4	15.25	196.6	14.27	261.96	18.75	374.5

The tests at 212° Fahr. were purposely made to approximate to the conditions obtained" in an axle which may have become heated by accidental friction at the journals. Heating under such circumstances has occasionally been known to occur to such an extent that the journals have become nearly red hot, setting fire to the grease-box, and even melting the brasses. Experiments relating to journal friction and train-resistance, by Mr. A. M. WELLINGTON, demonstrate that journals frequently, even in ordinary running, arrive at a temperature of from 120° to 150° Fahr.[1] In the case of overheated journals, an element of danger may arise from the peculiar modification of tensile strength and ductility in iron or steel, recently noticed by Mr. E. CORNUT, who observed that a change for weakness occurs in iron and steel at a certain temperature, as indicated by the great reduction of ductility assumed by iron and steel from about 572° to 662° Fahr.[2] Furthermore, it is obvious that in practical work an axle may be exposed to disintegrating effects, arising from a considerable divergence of temperature in its various parts. Thus it is possible, during the rush of a train at 60 miles per hour through a keen frosty air, for the exposed center of the axle to be at a low temperature, whereas the two journals and adjacent parts may be kept warm, or even hot; so that in the same axle there would be a manifest want of uniformity in the relative power of resistance to sudden impact between the middle and the ends. That this difference of resisting power at different temperatures is not trifling, the experiments of the present paper indicate. Moreover, these divergences of temperature in the same forging tend to produce internal thermo-currents, also exerting, to some extent, disintegrating influences. On referring to the more detailed records in the tables, it will be noticed that a considerable reduction occurred in the extent of the deflections after the first blow in the case of all the warm tests, from which it would appear as though the effect of continued impact at these temperatures was to partially harden, or perhaps render the iron rather more crystalline and brittle, and thus produce an apparent reduction of flexibility. The author has further observed this during testing at an ordinary temperature, though to a more modified extent, and with exceptions; but as no practical variation or reduction of deflection of this character was noticed in the cold tests, it may be inferred that the metal at low temperatures was probably already so far crystallized by the intense cold as to be not appreciably affected in this respect by continued impact, though perhaps it was influenced in a much less degree.

Repeated shocks, therefore, seem permanently to reduce the flexibility of railway axles. The author has, in other experiments, demonstrated that repeated concussion, applied to an axle, not only reduces its flexibility at ordinary temperatures, but also effects a modification of the tensile strength of the iron.[3]

An examination of some of the tables show that uniformity of results did not altogether prevail; the behavior of some of these exceptions appeared abnormal and peculiar. To further investigate this matter, the two halves of each axle which behaved abnormally under impact in the cold tests were turned down to 4½ ins. diameter throughout, and again tested, the one-half at a low temperature and the other at a higher temperature, but otherwise under similar conditions In every such instance these exceptional axles subsequently afforded results confirmatory to the general rule. The deviations from uniformity, which at first appeared like exceptions to a general principle, and consequently not easy of explanation, were doubtless due to some molecular difference in the material itself. The manner in which the falling weight would produce marks of indentation and contortion, after the first blow, from the true circular form of the axles, may possibly also have contributed to the variation in some of the results, as these could not be entirely due to irregularity of manufacture.

All who are acquainted practically with metallurgical processes are aware of the difficulty of obtaining exact uniformity in the nature of any two

[1] Minutes of Proceedings Inst. C. E., vol. lxxxv. p. 376. "Recent Researches in Friction." By John Goodman, Stud. Inst. C. E.

[2] *Iron*, May 1st, 1885.

[3] Society of Engineers. Transactions for 1879. [This has also been determined by Prof. THURSTON and others.—ED.]

forgings of iron or steel, though each may have passed through precisely the same treatment in manipulation.

Having examined the variation in the resisting power of railway axles, arising from difference of temperature, the next investigation should be in the direction of ascertaining, if possible the nature of the molecular changes which apparently result from the diversity of temperatures. The extent of these effects may be seen on comparing the great difference between the resisting power of the axles at 100° Fahr. and tha tmanifested at 7° Fahr. The results obtained indicate that the alteration in the properties of the metal cannot be an inconsiderable one. The change of molecular structure incident to the relative expansion and contraction of the metal at the various temperatures, necesarily exerts its influence, though in outward extent not comparable with the relative endurance of the axle.

TABLE IV.

Axles of Exceptional Behavior.—In addition to the experiments of Set I., recorded on Table I., four other axles of that set were tested, viz., Nos. 1, 3, and 6 at a temperature of 7° Fahr. No. 1 was tested with a weight of 1 ton falling 6 ft. = an "energy" of 13,440 ft.-lbs. for each blow. Axles 3 and 6 were tested with 1 ton falling 10 ft. = an "energy" of 22,400 ft.-lbs. for each blow.

Axle No.	Temp. Deg. Fahr.	No. Blows.	Total Deflection ins.	Total Force of Concussion Tons.
1	7°	47	61.94	2515.0
3	7°	23	54.38	1093.8
6	7°	34	86.0	1537.5
13	100°	19	42 5	950.4

Although these axles afforded exceptions to the general principle, yet when the halves of each axle were again tested respectively at 7° Fahr. and 100° Fahr., the warm axles stood considerably more than the c ld. A warm test-axle, No. 13, at a temperature of 100° Fahr., was also tested with a weight of 1 ton falling 10 ft. The results are given in the Table above. The axles were half turned over after each blow in every case.

It was observed, generally, in the tests of the halves of the broken axles, that neither in the cold nor the warm tests did the half of the axle show such total endurance as the axle manifested as a whole; this circumstance again indicating that the previous repeated heavy concussion had materially reduced the strength and fibre of the iron. The fact of the half axles having been turned down from 5¼ ins. diameter to 4¾ ins. diameter before retesting, and the supports having to be placed nearer owing to the shorter length of the half axle, would doubtless to some extent influence the result. Further, in testing the half axles in each case, owing to their short length, a small piece of iron about 1½ in. square was placed on the center to concentrate the force of the blow, but this was only adopted in testing the half axles. In many instances in Set. III., one or more very minute, but detectable, fine external cracks (about ¼ in. long), were noticed running across the center of the axles on the last blow previous to fracture, the iron axles thus showing premonitory signs of dissolution. Steel axles, when fracture occurs, appear to snap off without previous warning of this kind.

In the course of other experiments by the author, observations have been taken with great care on the relative dilatation of an axle at the temperatures of 0° Fahr., 100° Fahr., 212° Fahr., 392° Fahr., and 572° Fahr. Table V contains some extracts from the average results, of ten carefully repeated observations at each temperature, made with an extremely delicate micrometer vernier gauge.

TABLE V.—LINEAR DILATATION BY HEAT OF BEST SCRAP IRON RAILWAY CARRIAGE AXLES.

1000 p'rts at 32° F. become at	0° F.	100° F.	212° F.	392° F.	572° F.
..	999.768	1000.713	1001.722	1002.701	1003.650

[These expansions are larger than are commonly given, approaching that of brass.—ED.]

It may perhaps be reasonably assumed that, on the cooling of a forging, the molecules of the metal are arranged in what may be called their normal rigidity at the atmospheric temperature then obtaining. This normal point of rigidity may possibly vary according to the nature of the metal, and be some expression of its general strength and character. The effect of a further reduction of temperature would be a contraction affecting the molecules after they had thus normally arranged themselves. Sudden impact applied transversely to a forging during such a contracted condition, and at a lower temperature than its normal state of rigidity, would tend to induce internal molecular motion therein, and the same number of molecules would have consequently to vibrate under the influence of an equal, and sometimes even of a greater mean force of impact, than in the case of experiments at higher temperatures; but within an area reduced by contraction below the normal, they would presumably oscillate more rapidly, and rebound against each other with greater violence. The "mean force" imparted to an axle was greater during some of the earlier blows in each case in the cold tests (owing to the reduced flexibility at that temperature) compared with the warm ones.

The tendency of all this would be to induce earlier internal sorces of disintegration, and greater liabilty to earlier fracture, under the influence of repeated concussion transversely applied during low temperatures. The sudden impact also acted with a certain wedge like, or splitting-up force, and it may be presumed that contraction below the normal crystalline condition of a metal would induce varying properties therein.

The more gradual application of tensile-strain during cold has not only the advantage of time in its favor (an important element in connection with stress and strain, affording opportunity for gradual molecular re arrangement), but from the immediate commencement its elongating action affords longitudinally more space for molecular vibration, and consequent opportunity for molecular re-arrangement; hence probably one reason for the reduced liability to rapid internal disintegration, and greater endurance of iron under tensile-strain, compared with sudden impact under similar conditions of low temperature.

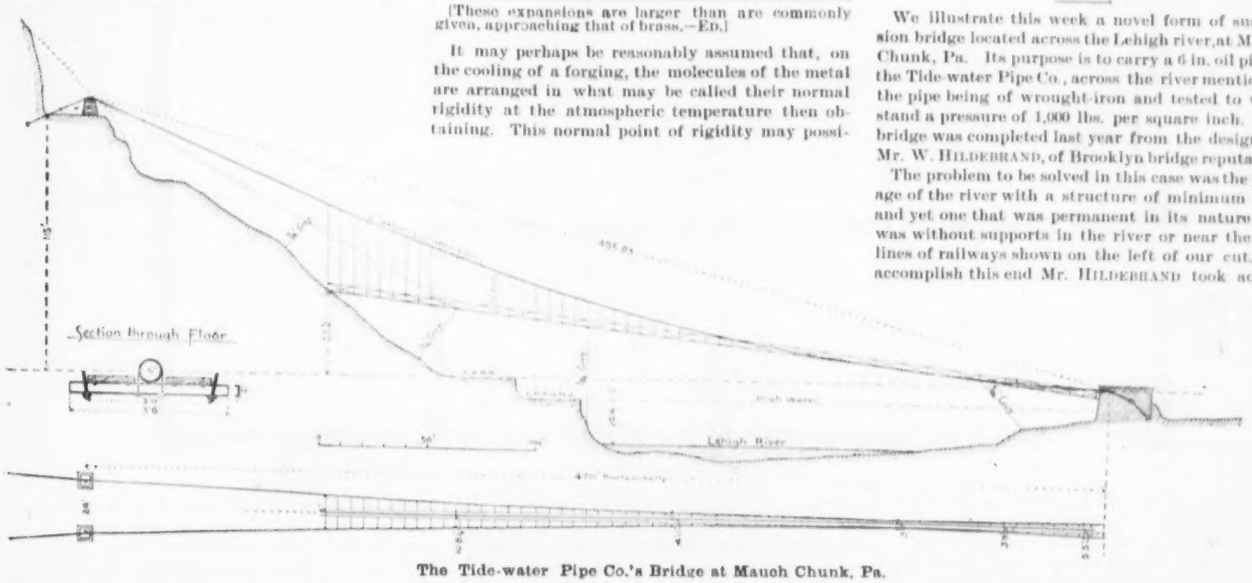
From a consideration of the varied experiments (the apparent exceptions encountered when placed under further treatment only assisting in establishing the rule), it may now be regarded as demonstrated tentatively, that low temperature materially reduces the power of resistance to continued heavy impact of railway axles; and some quantitative estimate of the extent of this reduction of endurance is afforded by the observations recorded.

The author's desire throughout the investigation has been to record observed facts with an unprejudiced mind, solely in the interests of engineering science, and he feels considerable diffidence in presenting so imperfect an experimental Memoir on a question of such interest.

A Novel Suspension Bridge.

We illustrate this week a novel form of suspension bridge located across the Lehigh river, at Mauch Chunk, Pa. Its purpose is to carry a 6 in. oil pipe of the Tide-water Pipe Co., across the river mentioned, the pipe being of wrought-iron and tested to withstand a pressure of 1,000 lbs. per square inch. The bridge was completed last year from the designs of Mr. W. HILDEBRAND, of Brooklyn bridge reputation.

The problem to be solved in this case was the passage of the river with a structure of minimum cost, and yet one that was permanent in its nature and was without supports in the river or near the two lines of railways shown on the left of our cut. To accomplish this end Mr. HILDEBRAND took advantage of the rocky bluff, and using that as a main tower produced the design given, which is practically the one half of a suspension span.



The Tide-water Pipe Co.'s Bridge at Mauch Chunk, Pa.

He used two 2 in. galvanized steel cables splayed as shown and anchored at one end in the solid rock and at the other in a masonry abutment. In the latter the links and anchor-plates are of the usual form. The cut fully illustrates the lateral dimensions and cross-section of the floor, a 3 in. channel beam forming the cross-girder and holding the ⅜ in. suspender rods. The guy ropes are ¾ in. in diameter in all cases.

During construction the cables were passed over the railway tracks, over which there is an almost constant traffic, by a simple but ingenious arrangement of platforms spaning the tracks and supported by central posts resting on the retaining wall between the two sets of tracks. The platform crossing the C. R. R. of N. J., or outer system, was supported in cantilever fashion by wire rope running to the central posts and anchored back, by similar ropes, to a set of posts and a loaded platform inside the L. V. R. R. tracks.

The Future Water Supply of Cincinnati.—The question of obtaining a better quality of water than that pumped at the present works has now been agitated for some years. No one doubts but that the present supply is at times very bad, and a more distant source, at Markley's Farm, has been suggested, and we believe the property is bought. Now Mr. GEORGE HORNUNG, the Engineer for the Newport, Ky., water-works, says that the removal of the pumping station to Markley's will not solve the difficulty. Newport is still more favorably situated as far as contamination is concerned, and yet water at times passes that point unfit for domestic use. As the Newport reservoirs hold 10 or 12 days supply, pumping can be stopped, usually, until the bad water goes by. This ample reservoir capacity is almost impossible for Cincinnati, and it must take the water as it comes, good or bad. It has been suggested that the channel contains the purest water, and it should be taken from that point, leaving the sewage and generally corrupted shore currents alone.

Heating and Ventilating System of the Mass. achusetts Institute of Technology.

Four years' records of the system which has been in use in the new building of the Institute of Technology at Boston can now be given. Of the three general methods employed for heating buildings, viz., by hot air furnaces, which draw the air from the outside of the building, or in some cases from the basement; second, by the direct heating by steam pipes or radiators of the air in each room, separately; or third, the indirect method, by placing steam heating pipes in boxed or large chambers beneath the floors or in the basement of the building containing the rooms to be heated, and thence conducting the heated air to the several rooms as in the first method, the system here established follows the last named method in its general features. The point of difference, or peculiarity, however, as compared with the methods in other buildings is primarily the attainment of adequate and even abundant ventilation rather than the mere question of warming the building with the object of economy in the coal required. Hence large air volumes are heated to comparatively low temperatures instead of using smaller volumes of highly heated air.

Fig. 1 is the first story plan of the building. It is of brick, 90 ft. × 150 ft. and 75 ft. high, containing 48 rooms varying in capacity from 3,000 to 60,000 cu. ft., and used for lecture and recitation rooms, physical and chemical laboratories, libraries, drawing, apparatus and storage rooms. The air supply allowed to each occupant is fixed at 1,500 cu. ft. per hour in the recitation and lecture rooms; 2,000 in the physical laboratories, 3,000 in the chemical laboratories, which are in addition supplied with well ventilated hoods; 4,500 in the organic chemical laboratory and 2,000 in the libraries, etc.

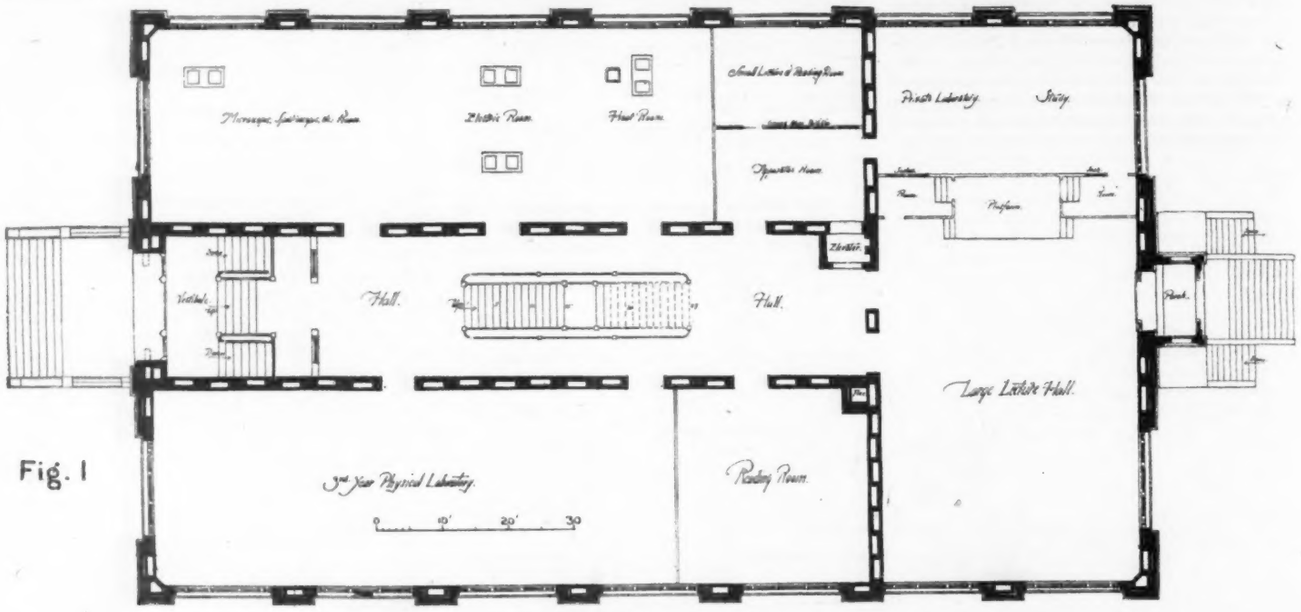


Fig. 1

Plan of First Story of Building

Following is the schedule of rooms with their capacities and required and actual flue area for ventilating and supplying the heating air, the required area being calculated at 500 ft. velocity per min.

The total capacity is 741,000 cu. ft. to be heated, exclusive of halls and stairways. Under these conditions, a quantity of air equal to the cubic contents of the rooms flows through in 12 to 13 minutes.; in the chemical department, in 6 to 7 minutes. With outside weather temperatures above 25°, 5,000,000 cu. ft. of air are required, instead of 3,500,000.

In the construction of the building, piers 2 ft. square and 5 ft. centers, running from stone foundation to roof, make up the body of the three interior walls, which are connected by shell walls containing the flues. Of these there are 79 in all, 3 ft. × 1 ft. cross-section, including 32 in the outer walls. Sixty-one of the flues are entire, 18 partial, or divided into sections forming smaller flues, one used for each room, on different floors. Twenty eight entire flues are in outside walls, 33 in the inside walls. The flues in outside walls are found to be objectionable as it is hard to obtain through them a proper air movement. The air inlets to the rooms are in the walls on the warm side, situated above the breathing line, usually 8 ft. above the floor. The outlets are at the floor on the same side and as nearly as possible under inlets. The action of the warm air entering is to remain above the breathing line until brought down by the chilling effect of the outer wall, and when so chilled it is of the desired

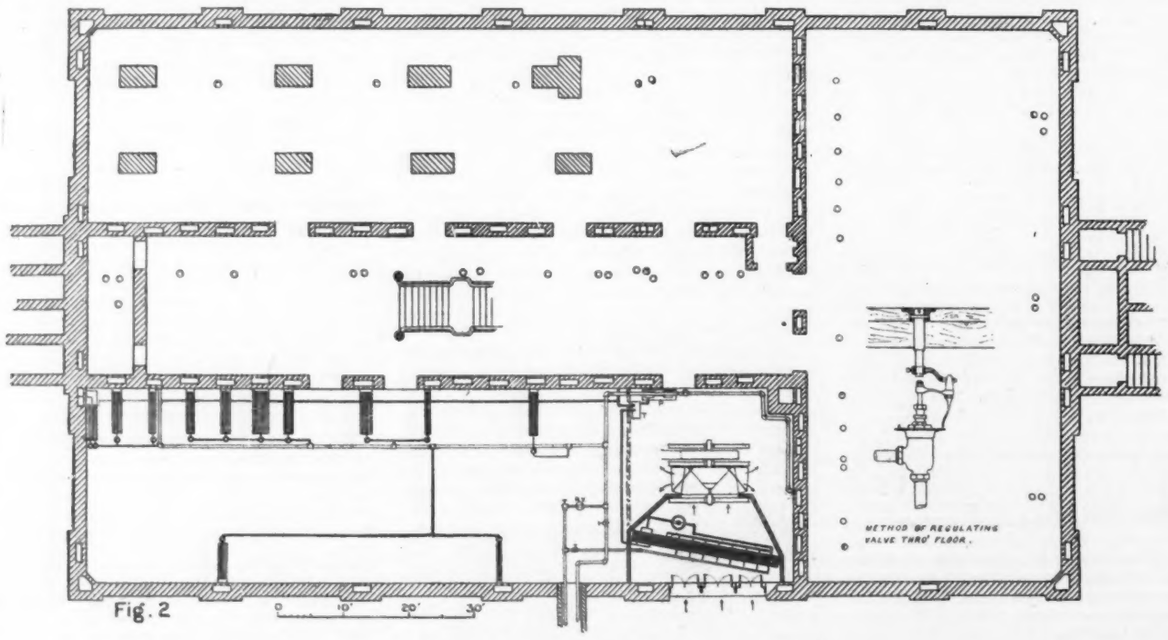
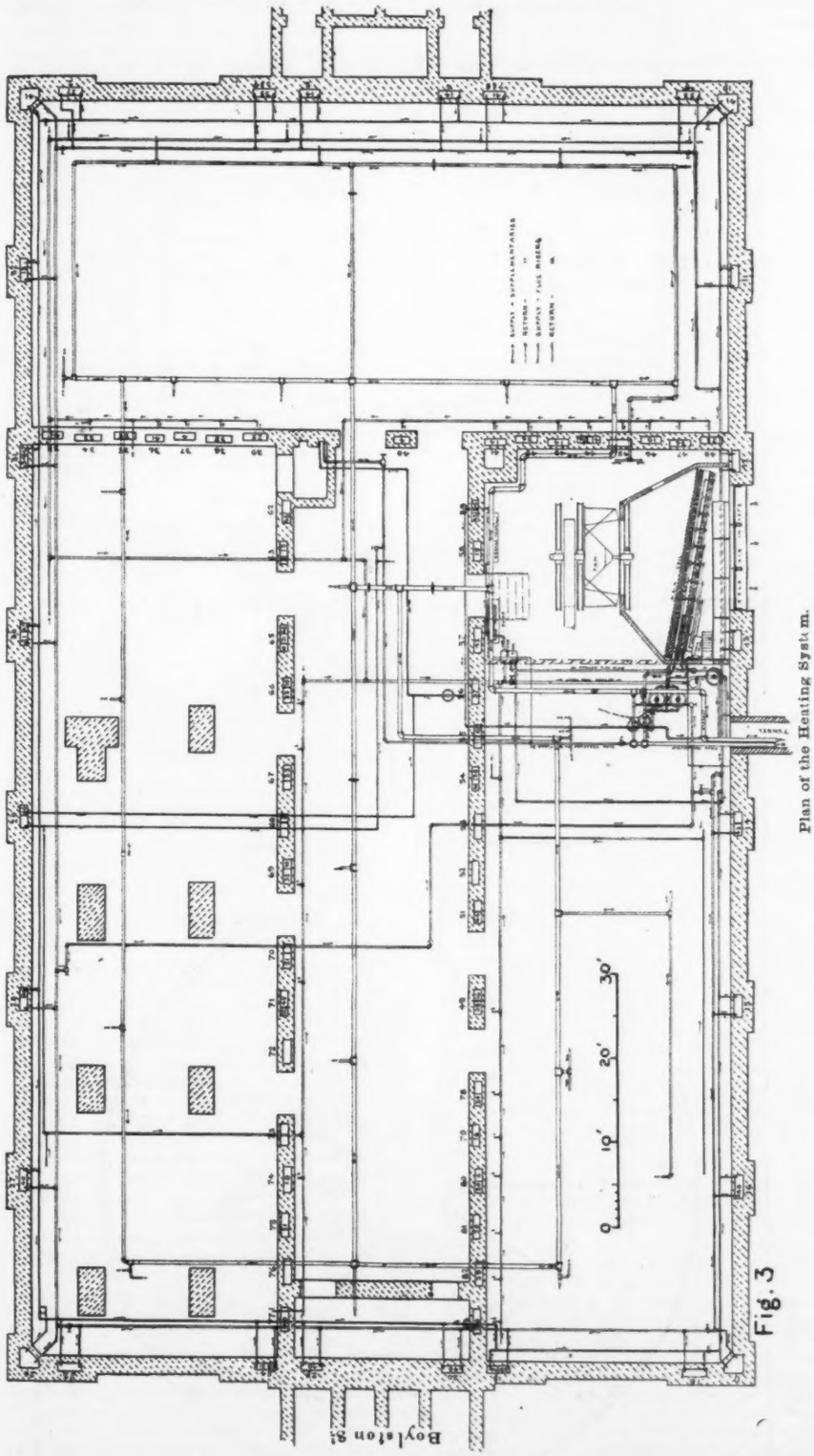


Fig. 2

Plan of Basement.

temperatures. The movement then is across the floor to the warm side where it escapes by the outlet. This arrangement is in accordance with the natural air movement and must act positively. Each room acts virtually as an enlargement of the flue, the air sweeping the room on its passage through the system until it escapes from the open tops of the flues.

The hot air reservoir is formed by a sub-basement, 4 ft. high, and of 14,000 sq. ft. area, extending under the entire building, and provided with a floor of cement, 4 ins. thick, laid on a sand and gravel bed and sloping to drainage wells to facilitate washing by hose pipe. This chamber, which is divided by the three inside division walls into four parts, also extends for an area of 700 sq. ft., where the flooring is removed, through the story above, air being admitted into it from outside through large windows having an area of 100 sq. ft.



Plan of the Heating System.

Fig. 3

Fig. 2 is a plan of basement showing supplementary coils at the base of flues by which the temperature and flow of air through each flue may be separately regulated.

Fig. 3 is a plan of the heating system. The entering air passes first through the main steam coils, where it is heated between 50° and 60°, being drawn in by the fan beyond. The piping is so arranged as to give several avenues of approach of the steam to any given supplementary coil, which equalizes the pressure and flow to all points.

No. room	Capacity cu. ft. (thousands)	No. occupants. Max.	Required air supply cu. ft. (thousands)	Requir'd flue area	Actual area sq. ft.
1	—	—	—	—	—
2	20	15	30	1.0	1.5
3	15	10	15	0.5	1.0
4	40	80	100	3.3	6.0
5	—	—	—	—	—
6	28	15	30	1.0	4.0
10	38	30	60	2.0	6.5
11	5	20	30	1.0	2.0
13	13	10	20	0.66	2.0
14	35	300	450	15.0	15.0
15	11	20	30	1.0	3.0
16	56	40	60	2.0	7.5
20 }	62	50	75	2.5	9.0
21 }					
22	27	200	300	10.0	9.0
23	23	150	2.0	7.3	6.0
24	48	—	—	—	5.5
30	9	35	53	1.8	2.0
31	17	70	105	3.5	3.5
32	11	40	60	2.0	3.0
33	8	25	38	1.3	3.5
34	11	3	9	0.3	2.0
35	27	200	300	10.0	9.0
36	23	150	220	7.3	7.0
37	13	15	25	0.8	3.0
38	17	70	105	3.5	3.0
39	18	30	45	1.5	3.0
40	60	150	450	15.0	18.0
41	60	150	450	15.0	18.0
42	18	30	120	4.0	5.0
43	10	20	40	1.3	1.5
44	8	10	30	0.5	1.5
45	7	15	30	1.0	2.0
46	5	3	9	0.3	1.0
46*a*	4	3	9	0.3	1.0
47	4	3	9	0.3	1.0
47*a*	4	3	9	0.3	1.0
48	6	3	9	0.3	4.0
Total	741.000	1,938	3,535,000	117.66	171.

Fig. 4 shows a cross-section through fan-room and building; also the flue openings.

Fig. 5 shows the fan. This is of the Sturtevant make, modified after Briggs pattern used at the Capitol, at Washington. It is 12 ft. diameter, 4 ft. deep, and comprises a single spider having twelve arms, at the extremity of each of which is a curved, wing-shaped float, 40 in. broad at base, and 20 in. at the front. The arms are bolted to an annular plate forming the fan back, and to this plate is bolted a cone, 9 ft. in diameter, having its apex towards the fan's mouth, which is left unobstructed, and is the minimum area of the entire system. On the front, the floats are tied by another annular plate, and stiffened by braces. At 90 revolutions per minute 15 H. P. moves 85,000 cu. ft. of air per minute through the fan against all resistances, and without the assistance of the heated flues. The reservoir contains by the fan's action slightly compressed air, the plenum pressure being equal to ⅛ in. water column.

(TO BE CONTINUED).

Putting a New Foundation under the Columbia Elevator, at Providence, R. I.

BY A. MC. L. HAWKS, ENGINEER IN CHARGE.

A novel and very successful piece of engineering has recently been completed at the Columbia Elevator, Providence, R. I., under the direction of J. HERBERT SHEDD (M. Am. Soc. C. E.) of that city. This included the making of a new foundation under, and rebuilding the dock wall and lower story on the dock side of the elevator without disturbing the remainder of the superstructure. The repairs were rendered necessary by a movement of the piling and the consequent twisting and cracking of the brick wall.

A short description of the building and its surrounding is necessary in order to understand the causes of this movement. Originally the ground on which it stands was a low marsh, covered at certain stages of the tide, "honeycombed" and presenting the spongy appearance so common to such low tracts of land, and thoroughly incapable of resisting the flow of water through it. When this part of the city became valuable, a light retaining wall was built upon small piles and the filling material was dumped on the spongy sedge behind it. Of course the movement of the water underneath it not being stopped, the filling material was continually being washed out. To remedy this, another and heavier dry masonry wall was built in front of the first, with the foundation carried down deeper.

In 1878, when the owners decided to erect an elevator, this wall was selected to carry one side of the building. So it was gone over on the *outside* with Portland cement mortar to give it the appearance of strength, and then, without any more preparation the building was placed upon it.

The structure is essentially in two parts, although from without it looks like one. The street end is a five story brick storehouse where flour in barrels and all grains in bags are kept. The rear end is occupied on the two lower stories by the milling department, and above these are the grain bins running as high as the roof of the warehouse. Between these parts is a 12-in. fire wall rising to 5 ft. above the roof. A 20 ft. gangway, on the level of the street, occupies the half of the lower floor next the dock, with two tracks in it for easily handling the grain from the railroads. In consequence of this the dock wall had to carry the extra weight of one-half of the wall over this opening in the front, rear and fire walls. And this dock side of the building was weakened by some arched openings 11 ft. high and 6 ft. wide, made for the purpose of admitting light, and farther by a breach 2 ft. wide in the middle of the elevator proper, for the housing of the ship leg, which virtually made two unconnected parts of this wall.

On the back of the top of the dock wall (as in Fig. 2) was set a coping of granite 1 ft. thick and 2 ft. wide, and on this was built the brick wall 2 ft. thick under the grain bin, and for the lower two stories

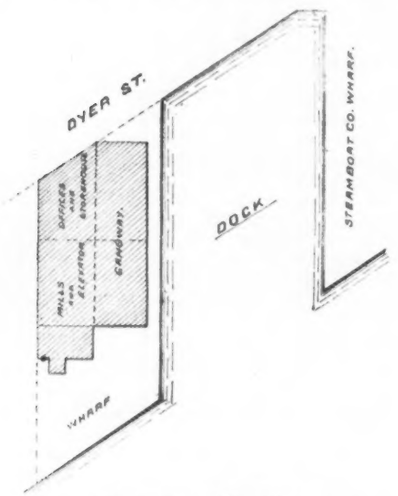


Fig. 1.—General Location.

of the warehouse reducing to 20, 16 and 14 ins. on the other three stories. On the inner side of the gangway is built an 18 in. brick wall for the purpose of enclosing the offices and mills, and to carry the central weight of the building. This is built upon the most substantial foundation of all—a rough rubble laid in cement, and extending deeper than the others.

Soon after the lessees moved into the new structure, trouble began from the sinking of numerous small places in the gangway. These would be filled up, and in a very few days even larger ones would appear in the same spot. Just about this time the whole harbor and all the docks were dredged to about 2 ft. deeper than before, and after this the increase in size and numbers was rapid. A line of Shore steamers occupied the other half of the slip and, by its continuous churning of the waters, also helped to make matters worse. Not long after this a small crack appeared in the fire wall, and then another and another. By this time the lessees became frightened as well as annoyed and applied for a remedy. Tie-rods clear through the building—bracing of various sorts and like ineffectual means were resorted to, but without success. Matters continued to grow worse, more cracks appeared—difficulty in keeping the engine and shafting in line was encountered until, at last, it was so bad the machinery was forced to lay idle. Then Mr. J. HERBERT SHEDD, engineer, was retained, and with the writer as assistant, at once had the lower floor re-surveyed and all cracks, etc., noted. The whole dock side was in a terrible condition, and looked scarcely able to stand until it could be repaired.

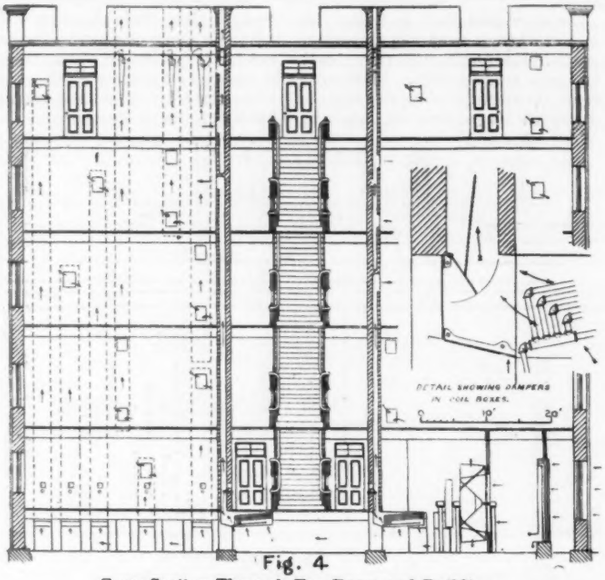
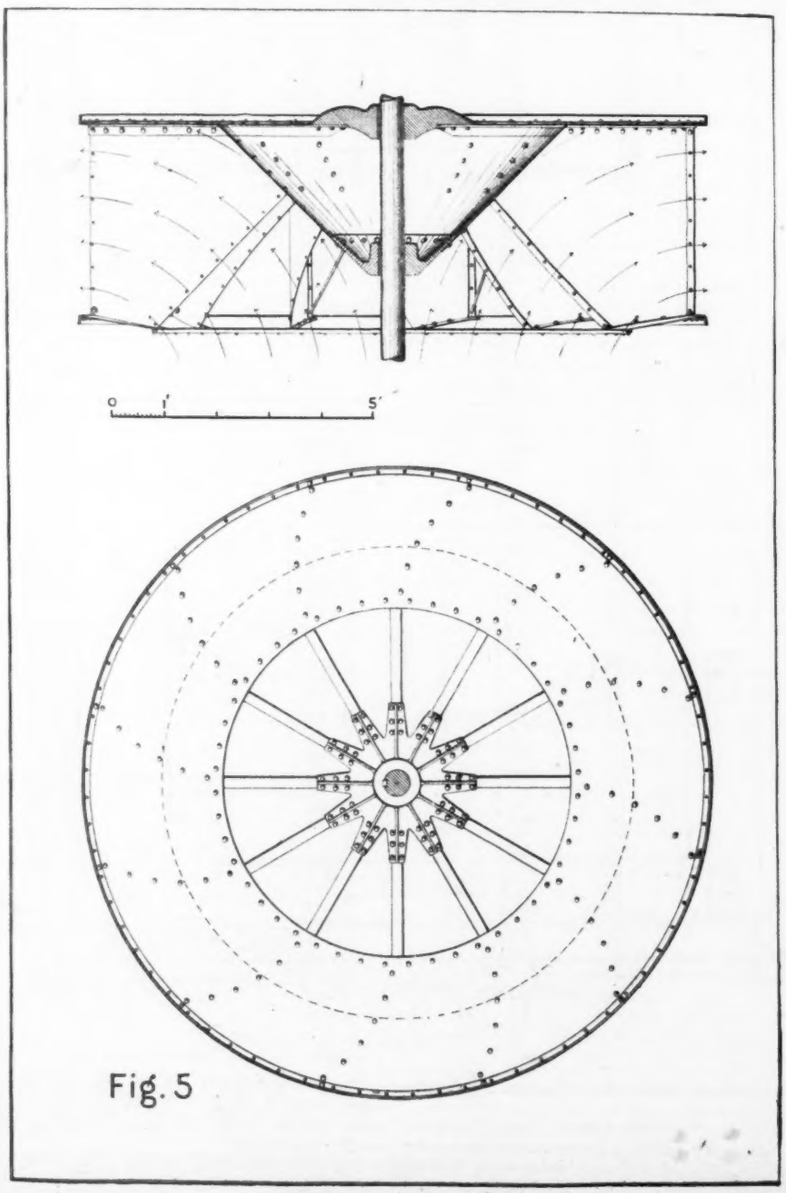


Fig. 4

Cross-Section Through Fan Room and Building.



The Sturtevant-Briggs' Fan.

We assumed that the inner wall of the gangway was about in the position laterally that it originally occupied, because the pressure was almost entirely straight down. From this we found that the front end of the outer wall just beyond the middle had bulged out about 0.60 ft., and at the rear end it had moved *in* about 0.04 ft.

In regard to levels both the outer and inner wall were very irregular. The front one was highest and the fall from there to beyond the fire-wall was nearly regular, reaching 0.25 ft., on the outer wall at that point. But from front to rear it was very irregular, a difference of about half an inch occurring on the two sides of the 2 ft. space left for the ship-leg. On the inner wall the fall was only about 0.10 ft., but here it continued through to the end. We noted five large cracks in the walls from a quarter to half an inch wide and from 4 to 10 ft. long. The smaller ones were also marked to observe extension. The granite coping was split twice, once being in the center of one of the 6 ft. openings where it had bulged up in the middle about half an inch. The fender piles had at some places broken at the base of the wall, at others pulled through the bolt-hole and were swinging to and fro some 5 ft. from the cap-leg, and a few were still in place though badly strained.

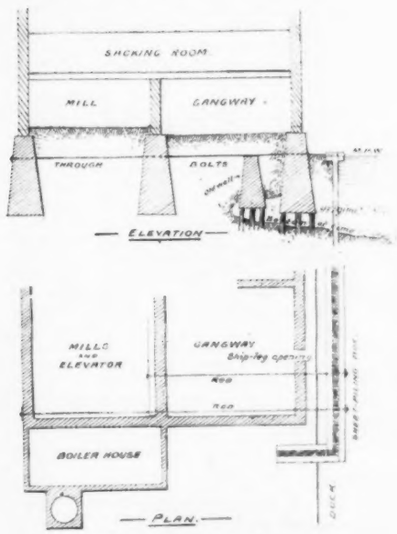


Fig. 2. Plan and Elevation.

The sham face of the dock wall had thoroughly broken up exposing all its weakness. And, in fact, it was all in such a condition that when the plans were completed, contractors were afraid to bid, and some even went so far as to say that they would not risk their lives or those of their men in such a trap.

So it was decided to do it by day's work, and as soon as sufficient material could be collected it was so begun. We labored under the disadvantages of having to leave the steamboat company's half of the slip open for their constant use, and also to leave the lessees of the building as much room as was possible, and to permanently occupy as little of the dock as possible.

The plan adopted was to box in the whole side of the building, to fill this box with cement, and then to shore up on this box so that the lower portion of the wall could be taken down and rebuilt. The box was made up of 8 in. × 12 in. Southern pine sticks driven down as sheet-piling, the depth attained being usually 15 to 20 ft. in the mud.

Two 8 in. × 12 in. stringers were clamped into place to serve as guides. And every stick was grooved to receive a 2 in. spline which served partially to guide the next pile into place and to make the whole box-work more nearly water-tight. The piles were sharpened on the lower end to make them "hug up" as closely as possible in driving, and a jet of water was introduced at the point to facilitate the work.

At first a light hammer raised by hand power was used, as it was feared that a heavier one would jar and crack the building too much. But it was soon evident that such would not be the case, so a 1,000 lb. steam-hammer, striking from 60 to 80 one-foot blows per minute was used. To tie the box-work into place a trench was dug inside of the inner wall of the gangway, and, at the level of the stringers on the outside, an 8 × 12 in. timber was bedded securely. Three-inch bolts, 16 ft. apart, extending entirely under the gangway connected these, and were secured up to a firm bearing, so that any future movement would affect that half of the building alike. And at the rear end, where the greatest trouble might be feared, the bolt was extended clear through to the other outside wall where a 3 ft. square washer plate was put on, so that any change would have to move the whole end of the building. A square offset was made at each end of the building, extending inside beyond the old retaining wall. As fast as a 16 ft. section was finished and bolted in place, concrete (1 part Norton's cement, 2 of sand, and 3 of gravel) was poured between the dock-wall and the box work. This would fill part of the space where the mud had been washed away, but still would leave the larger part empty. It was quite a problem how to do this successfully, but it was finally accomplished in this way. A piece of 4 inch wrought-iron pipe 20 ft. long had a cast-iron head, with a half nose coupling on top, and a large relief valve on the side, attached. This was sunk in the gangway by jumping it with a block and tackle, while through the hose connected with the top sufficient water pressure was maintained to keep the lower end free.

At starting the water would overflow slightly, but as soon as the crust was broken through, down would rush the water and the pipe would sink from its own weight. Hose connection would then be made with a barrel on the fourth floor of the building, and through this 2½ inch hose a grout (1 part Norton's cement and 1 part sand), would be forced into this cavity with the pressure due to a head of about 45 ft. Whenever no more could be forced in, the relief valve was opened, and the grout in the hose was allowed to escape. Then it would be filled to the height of the barrel with clear water, and this allowed to stand a few minutes. If it broke through filling was resumed. If not, the iron pipe was raised till it reached the point where it would break out. The filling would then begin again, and so this would be repeated till nearly to the surface. This was one of the hardest parts of the work to manage, and one that required "eternal vigilance." For the grout would clog at every sag or quick bend in the pipe, and once caught it seemed to set almost instantaneously. And owing to the drawing up of the pipe such sags and bends were almost impossible to avoid. Towards the end of the work the remedy suggested itself, however. As the hose wore out, which it did quite rapidly, it would be shortened by repairs, and so we had an assortment of lengths, by which we could, at each stopping, change pieces till we got the desired straight line.

These grouting holes were sunk every 6 ft. along the building, and were usually kept about 50 ft. behind where the pile driving was then going on. Yet they would force out considerable material at that distance. And even when the reset was completed at the front end, cement cream and light mud could be distinctly seen issuing from the dock wall beyond it, showing that a thorough current had been maintained under the wharf. Over a thousand barrels of cement were used in filling in the box-work, the hole sunk near the broken granite coping alone taking 96, and two others more than 50 apiece, showing that there could have been hardly more than a mere crust of earth on the surface.

When the filling was satisfactorily completed and all the other work done, heavy timbers were put through the walls at the third story floor, and by means of powerful screws the weight of the building was taken upon these shores. The instant this was done the wall, which had been curved inward, jumped into a straight line with quite a sharp report. All below this floor was then torn down to the bottom of the dock wall—a new dock wall was built on the concrete which had been now run in from outside of the old wall; the brick wall rebuilt on the *middle* of the foundation wall; the elevator and bins raised to their original position, and the wall rebuilt without any opening being left for the ship-leg (which was housed outside). The fire-wall was then taken down nearly to the roof on the dock side and rebuilt; many of the window arches rebuilt and the building put in as good shape as possible. When the shoring was taken out, the green work pulled away from the old places, making a very few small cracks. At once the croakers, who had prophesied, evil from the commencement of the work, cried "I told you so," and gave the building a month to crumble into the dock. But now at the end of two years no more cracks have appeared, all runs smoothly, and no more trouble has been experienced with the holes in the gangway. And as the wood and iron were thoroughly coated with preservative, they will last many years. And the concrete having so long to harden, will be like a solid rock by the time the wood-work has decayed enough to cause its removal.

Transport of Petroleum in Russia.

The subject of transporting petroleum by pipe-line, from Baku to Batoum in the Caucasus, is again being agitated, and *Engineering*, of Feb. 3, gives an elaborated plan proposed after an examination of the ground to be passed over. The detail of the plant is very evidently founded on the American practice in oil pipe-line work already fully described in this journal.

As applied in the Caucasus the line would be 497 miles long with conduit pipe 8 in. internal diameter. This line would be divided into 24 sections with a similar number of intermediate pumping stations, each station containing 4 engines of 150 H. P. each, one engine in each being a reserve. The total annual flow through the conduit is estimated at 1,311,000 tons, or a discharge of 110 cu. ft. per minute for 337 working days. The maximum working pressure is figured at 900 lbs. to the square inch, with a pipe resistance of twice that pressure.

The pipes will be of wrought-iron, 8 in. in internal diameter and $\frac{5}{16}$ in. thick. The wrought-iron sleeves at joints will be ½ in. thick and 4¾ in. long, with 8 screw threads to the inch. Before laying the pipes will be coated externally with coal-tar.

The pipes will be laid on the surface in undulating lines, with a maximum deviation from a straight line of 13 ins. in every 330 ft. When the temperature falls below the freezing point the pipes will be buried at depths ranging from 1 to 5 ft. below the surface; if rocky soil prevents burying, the pipes will be covered with earth to a corresponding height.

The arrangement for pumping stations, tanks, etc., is practically the same described in our issue of June 13, 1885, in fact the whole plant is simply a copy of the latest practice in American pipe-lines. The pumps are not described, but they will doubtless be likewise copied from the only engines that have proved themselves through a period of years capable of standing the severe duty to which such oil-pumps are subjected.

Vulcanized Wood Pulp.

In the last number of the *Journal of the Association of Engineering Societies* is a short article by Mr. MARK L. DERING, of Cleveland, O., on a new process of manufacturing useful articles out of wood pulp.

The basis is spruce pulp in sheets as it comes from the mill: this is again beaten into pulp and with it is mixed pitch, in the proportion of 1 to 20, which latter is first treated in an electric bath which "changes its nature entirely." The pulp and the pitch are put together in a beating machine in which the water is also heavily charged with electricity. The product is then rough pressed into shape, as ails, basins, etc., in perforated moulds, and is then again pressed in smooth moulds and vulcanized in the latter at a temperature below 300° Fah. A second vulcanization at 350° Fah. completes the operation.

The product is claimed to be solid and impervious throughout; it has a tensile strength of 9,000 lbs. to the square inch. It is almost as good as rubber as an insulator and will not burn. The material costs 2 cts. per pound and a barrel, for example, can be made in 10 to 15 minutes.

ACCORDING to Chinese advices, the authorities of that country have a summary way of dealing with the officials who have shown remissness in not taking proper measures to prevent the recent floods on the Yellow river. Five of these officials including the Sub-Prefect and Mayor of Shang-an, have been condemned to the Cangue, or wooden collar, for a period of some months.

The Physical Phenomena of Harbor Entrances.

The paper by Prof. LEWIS M. HAUPT on the above subject, and for which paper the Am. Philosophical Society awarded on Dec. 16 last the rare Magellanic Premium, embodies sound and very new and important observations upon the physical phenomena at harbor entrances, their remedies and the defects of present methods of improvement.

The original paper is too extended for the space at our command, but we can give the general scheme and the conclusions of Prof. HAUPT. The first part of the paper is devoted to the presentation of observed facts in connection with the subject, and the typical forms of harbor entrances are thus described:

In examining the plan of any entrance it is generally found that the ends of the islands forming the outlying cordon are elongated into spits or hooks, curving inward, with a smooth outer and a rugged inner shoreline; that one of the points is sharp, and the other blunt or round headed; that the sharp point usually recedes from the general coast line; that the seaward slope of a cross-section of the bar is less steep than the inner slope, except where the ebb stream cross it; that the flood tide usually approaches the entrance at first in a direction more nearly parallel to the sharper lip and normal to the blunt one, rolling up the gentler slope and depositing sand on or within the crest of the bar, where "breakers" are found; that along the shore of the sharp point there is a shallow channel cut out by the flood, and curving around the blunt, projecting lip of the gorge there is the main deep water channel produced by the ebb. Between these limits are found one or more secondary or swash channels, which provide egress for the lateral overflow, so to speak, of the ebb and correspond to the waste weirs or crevasses of a stream.

The *internal* forces at work are those resulting from the form and extent of the inner basins, the volume of the tidal prism and the relative directions of the tidal and river currents as they approach the gorge. The *external* effects are those resulting from the form, position and extent of the banks which have been piled up by the flood and obstruct the ebb. Hence it follows, if the flood pressure and movement is from the south side of the entrance the channel will be to the north, as the banks will be more extensive on the former side, offering greater resistance and deflecting the ebb stream and crowding it in until it is supported on its opposite flank by the shore. If the flood resultant comes in from the northern side, the reverse is true.

Again, if the confluent ebb streams of the inner basin are so directed by natural or artificial constructions as to commingle and unite their energies, instead of opposing one another, as most frequently occurs, the momentum of the united stream will be greater and the crossing on the bar be consequently deepened. This will be better understood by observing that the inner basin is generally composed of three subdivisions, viz.: One extending along the islands on either hand, and one stretching to the rear. At the ebb of the tide the prisms of discharge are all approaching the gorge at the same time. In consequence of the inward flexure of the spit at this place, one or both of the lateral currents are reflected into the face of the main discharge, and thus diminish its energy, which it is the object of the engineer to conserve.

An examination of the various entrances leaves no doubt of the existence of such a littoral flood movement, whereby the sands of the beaches are transported to and deposited in front of the inlets, where the racing waves, no longer resisted by and reflected from the shore, escape through the break in the barrier which forms the outlying sandy cordon defending the coast.

Theory of Flood Resultant.

The paper then goes on to treat of ocean dynamics by showing how "the effect of this racing of the waves in search of an escape from the pressure of the flood tide is to scour off and prolong the sharper lip at the gorge, and to flatten out and beat back the opposite shore;" thus shifting the position of the entrance as illustrated in the accompanying map of Barnegat Inlet.

Prof. HAUPT states that the effort of the tide is not to oppose the flood resultant directly, but to turn away therefrom and assume a direction as nearly as may be at right angles thereto. Thus the flood will roll the sand up the gentler outer slope to the crest in a direction normal to the main channel, while the ebb will sweep across its path on the line of least resistance, which lies behind and parallel to the barricade formed by the flood, and *effects* its *maximum result at* the *point of least resistance*, which is that point in the bar farthest removed from the direct action of the flood. This action is best illustrated by the diagram here given, in which *A* is the point of maximum flood force and *B* the point of minimum flood resistance.

To determine why the resultant observed should sometimes come from the northeast and at other times from the southeast, an examination must be made of the phenomena attending the approach of the tidal wave, and the position of the co-tidal lines studied with reference to the coast-line. For this purpose the general co-tidal maps of Prof. GUYOT and the more detailed maps of Prof BACHE are available. Though these furnish rather meagre data, there is sufficient to confirm the existence of the alleged resultant movements and to verify the reliability of this method of determining the forces by their effects. The paper then goes on to discuss these effects and their causes taken in connection with tidal action, as exemplified on the South Atlantic coast of the United States, using for this purpose a number of Coast Survey Charts.

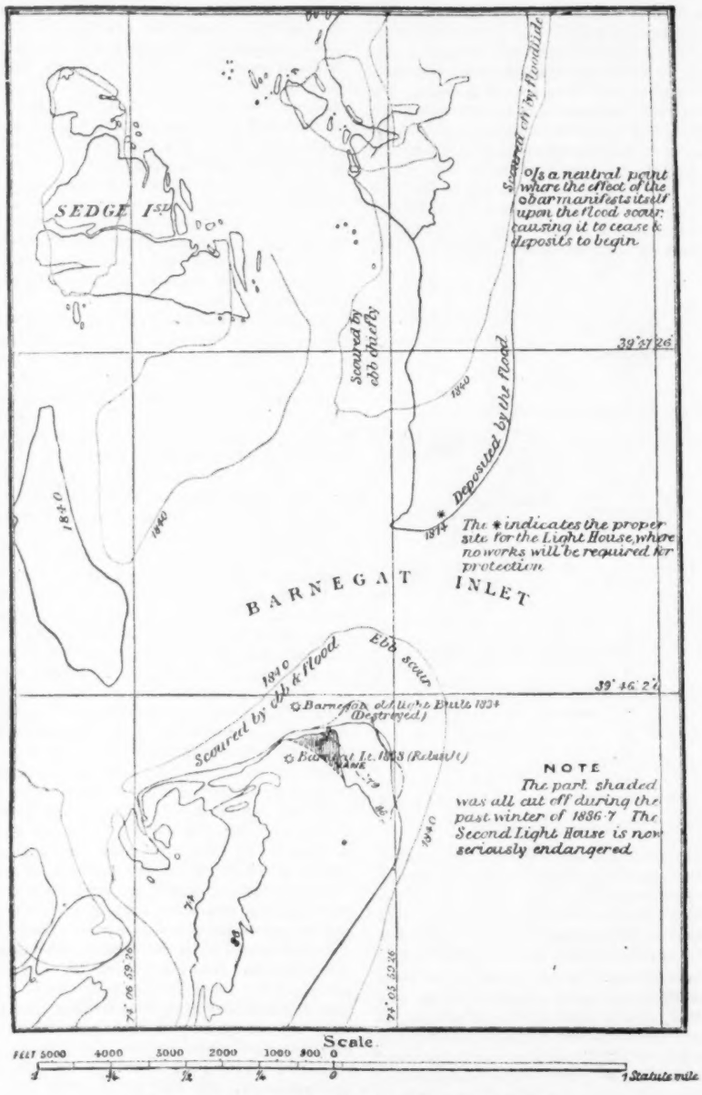
The jetty system as at present applied is thus laid down by Prof. HAUPT:

1. "The works should be so designed that "they should not impede the inflow to such an extent as to prevent the tidal basin being filled at every influx of the tidal wave.

2. "They should control the outflow to such a degree and in such a manner that a channel of the required depth will be maintained through the bar.

3. "They should not, to any considerable extent, cause a movement seaward of the main body of the bar; that is, the general position of the bar should be independent of the effects produced between and beyond the heads of the jetties."

Prof. HAUPT says that the attempt to reconcile these conflicting conditions, as to concentration of ebb and free admission of flood, resulted in the adoption of low or submerged jetties as tried at both Charleston and Galveston. The result has been to push the bar seaward without materially deepening the water on the crest, and the works are so designed as to divert the ebb stream directly into the face of the flood where the resistance to be overcome is the greatest. In the author's opinion even the modified Galveston plan will still violate the first of the above established principles, and have the further serious objection of directing this diminished tidal prism into the face of the flood, near its point of maximum energy, with nothing to lower the plane of tidal scour except the small amount of head due to contraction.


SEDGE I.
Scoured by ebb chiefly
Deposited by the flood
Scoured by flood tide
Is a neutral point where the effect of the bar manifests itself upon the flood scour; causing it to cease & deposits to begin
The * indicates the proper site for the Light House, where no works will be required for protection
BARNEGAT INLET
Ebb scour
Scoured by ebb & flood
Barnegat old Light House 1834 (Destroyed)
Barnegat Lt. 1858 (Relanded)
NOTE
The part shaded was all cut off during the past winter of 1886-7. The Second Light House is now seriously endangered
39° 46' 2"
39° 45' 26"
1840
1845
Scale
FEET 5000 4000 3000 2000 1000 500 0
Statute mile

Barnegat Inlet, Showing Gradual Change of Channel.

Prof. HAUPT presents, in conclusion, a summary of the features claimed as meritorious in his communication, as follows:—

1. The determination of the character, direction and relative intensities of the forces acting upon any harbor entrance, from a study of the submerged topography and other local physical features.

2. The discovery of the existence of typical forms in the sandy spits bordering the entrance, which will in general indicate the direction of the resultant movement.

3. The recognition of the fact that the proper place for the ebb discharge, or channel over the bar, is as far removed as may be from the point of direct attack of the flood resultant, when the direction of the latter is not normal to the coast.

4. The definite enunciation of the principle that the trend of the coast with reference to the cotidal line will

in general indicate at once the proper position for defensive work.

5. The presentation of an original form (in plan) of breakwater, whereby the natural agencies are materially *aided*, without serious interference with either the flood or ebb forces.

6. A method of improvement whereby the *internal* currents are concentrated and conserved for more efficient scour after passing the gorge.

7. A plan for utilizing the natural tendencies of the flood to cut a beach channel which shall be available for the lighter draught vessels.

8. The enunciation of the principle that the cause of the angular movement of the ebb stream after egress is due to the general form of the exterior coast line, which causes a racing of the tidal crests, from the outer capes towards the bight of the bay, and that the *flood components thus generated are the principal forces* which build the bars and shift the inlets. This incessant semi-diurnal action of the flood is *the controlling element* in the forces affecting the magnitude and position of the bar. Storms and winds may modify and shift the deposits, but eventually the flood re-establishes the original conditions.

9. The free circulation and ingress given to the flood by the detached breakwater, so designed as both to oppose a portion of the flood and produce interfering waves which deposit sand outside of the channel whilst it also aids the ebb in its attack on the bar by defending its channel and concentrating its volume.

10. For a given site and stage of water the flood movement approaches in the *same direction*, hence the resisting and regulating works should be placed on the near side of the proposed channel. If on the far side, they would be worse than useless, unless for shore protection.

11. No artificial re-opening of an outlet which has been closed by this flood component, can be maintained without auxilary works to deflect and modify its action. Dredging is only justified when the interests of navigation are sufficient to maintain a continuance of the expense and no other reasonable methods are available.

12. The ability resulting from these general principles to construct works requiring a lesser linear development which will produce greater navigable depths at less cost.

13. The abolition of the risks and difficulties attending the navigation of narrow jetty entrances in times of danger.

14. It frequently happens that the requirements of navigation and tidal concentration are conflicting, the former demanding wide entrances, the latter, on account of insufficient tidal volume, narrow ones. This debars the usual jetties and prevents improvement. The plans herein proposed are eminently adapted to meet such exigencies.

On the Action of Boston Water on Certain Sorts of Service Pipe.*

Although galvanized pipe is used to a considerable extent for distributing soft water, and although the general nature of the action of water upon zinc is known, there are very few results of quantitative analysis accessible which show the amount of zinc actually taken up by the water under the circumstances of ordinary practice. We have recently made some experiments in this direction.

The principle on which the so-called "galvanizing" process rests is that, under ordinary circumstances, zinc is slightly electro-positive to iron, and if the two metals in intimate contact are simultaneously immersed in water the zinc will be acted upon rather than the iron. This principle is only partially realized in practice. As long as the zinc coating is perfect the iron is protected, but if the zinc coating be imperfect, or if it be removed, as it is liable to be in coupling pipes together, then the iron is acted upon as well and compounds of zinc as well as of iron are formed and carried forward with the water, or form a sediment which gradually chokes up the pipe. One of us has already stated elsewhere, as the result of experience, that it will usually be found possible to detect zinc in water which has passed through any considerable length of zinced pipe, and has expressed the opinion that with most waters which are used for water supply the amount of zinc in suspension—generally a hydrocarbonate—and in solution (in whatever form) is too inconsiderable to form the basis of a sanitary objection to the use of the pipe.

In our recent experiments we employed a length of about 39 ft. of half-inch galvanized pipe connected with the water service of the building in such a way that the water in the pipe could at any time be displaced by fresh water without allowing air to enter. Usually for a test an amount of water was drawn off equal to or slightly greater than the capacity of the pipe.

The experiments were continued during a period of 3 months. We found zinc in solution and in suspension, in not widely varying amounts, whenever water stood in the pipes from 7 to 70 hours.

Water standing several days in the pipe contained no greater proportion of zinc in solution, though that in suspension was increased, and at the end of the 3 months the quantity of zinc found was only slightly less than at the beginning.

The water contained in solution 0.3 to 0.6 parts per 100,000 zinc. In suspension 1.5 to 2 parts per 100,000, 0.3 grain per gallon in solution, and 1.0 grain per gallon in suspension. No zinc was found in water with the regular flow, but when the rate was decreased to about one quart per hour, 0.9 part per 100,000 of zinc in solution and suspension was found.

The inevitable inference to be drawn from these results is that the zinc coating is slowly but continuously dissolved, and it becomes a question of interest to consider the length of time the coating will last. Some experiment on the thickness of the zinc coating and the depth to which it penetrates the iron were made.

Some rods of wrought iron about 6 ins. long were carefully centered and turned off by a lathe for about 4 ins. of their length. The diameters of these were measured with a micrometer screw caliper measuring to one-thousandth of an inch. The rods were now treated exactly as iron pipe galvanized, *i. e.*, by dipping the iron previously cleaned by immersion in muriatic acid, into a bath of melted zinc with frequent additions of sal-ammoniac, the centering being preserved by filling the holes with putty, which was afterwards easily dug out. The increase in thickness was noted. The rods were turned down by this amount, the turnings collected and analyzed for zinc and iron. Other turnings followed of varying thickness which were also analyzed.

The results are given in the following table. The measurements are the thickness of the consecutive layers removed;

No. of rod.	No. of consecutive turning.	Meas. before galvanizing. In. dia.	Meas after galvanizing. In. dia.	Thickness of turning.	Per cent. Fe.	Per cent. Zn.
I.	1	.901	.905	.002	2.19	97.08
I.	2	.901	....	.0035	93.31	4.33
I.	3	.901	....	.002	96.04	.93
II.	1	.901	.905	.002	1.87	96.42
II.	2	.901	....	.003	65.24	33.18
II.	3	.901	....	.0025	....	tr.
III.	1	.901	.905	.002	1.70	97.20
III.	2	.901	....	.0025	62.04	33.95
III.	3	.901	....	.001	87.09	13.23

This table shows the increase in thickness due to galvanizing to be a ring of two one-thousandths of an inch thick and that zinc does penetrate slightly into the iron, forming an alloy.

It will be seen that at the rate of wear indicated in the first series of experiments the coating of zinc would not last many months.

The zinc coating is not an even layer over the whole surface, but is thinner in places. This was made evident by experiment as follows: On immersing one of the galvanized rods or a piece of pipe in water, points of iron rust appeared at irregular intervals. In the water drawn from the pipe as above described some iron was always found with the zinc.

Some experiments were also made to ascertain the composition of the insoluble precipitate formed by the action of water on zinc. A quantity of chemically pure zinc was placed in a large flask and covered with filtered Cochituate water. The precipitate formed was collected from time to time, and the water was renewed, and was dried over sulphuric acid, one portion contained

ZnO	73.08
H_2O	16.90
CO_2	10.02
	99.92

Another portion dried longer gave

ZnO	78.44
H_2O	10.98
CO_2	10.58
	100.00

This composition nearly corresponds to $5H_2O,2CO_2,8ZnO$. This zinc hydrocarbonate differs somewhat from those investigated by Rose and von Pettenkoffer.*

At the same time as the foregoing experiments, tests were made of a pipe protected by a coating of lead, tin and antimony (in the proportion of about 80-12-8 in the sample examined) instead of zinc. The pipe is called kalamein.

Our experiments show that the coating on our sample is not evenly laid on, the spots of iron showing as referred to in the case of the galvanized pipe.

Our experiments extended over nearly a month, and the amount of lead and tin in the water drawn from the pipe was not appreciably diminished at the end of the time.

We also arranged brass pipe in the manner described for the galvanized, except that the two ends were connected so as to enable us to heat the lower part and keep up a circulation of water through the pipe, and to ascertain what metals if any went into solution. Zinc and copper were found in small quantities but constantly present.

As a further evidence of chemical action the dissolved oxygen in samples of water which had remained in contact with the pipes for fifteen hours was determined by Schutzenberger's method, fully aerated Cochituate being taken as a standard and the tests being made for several days in succession.

Freshly drawn and fully aerated Cochituate gave per thousand of

Kind of pipe.	Dissolved Oxygen.
Common iron pipe, from faucet in the laboratory, after 15 hours contact	2.1
Brass pipe	1.6
Galvanized pipe	0.7
Kalameined pipe	0.6

*By the late WM. RIPLEY NICHOLS, Member of the Boston Society of Civil Engineers, and L. K. RUSSELL. Read Oct. 19, 1887, by Prof. L. M. NORTON, from the Journal of the Association of Engineering Societies.

*Rose, Pogg. Ann. 86, 207-141. Also v. Pettenkoffer, Abh. D. Tech. Commission, I., 149.

Conveying Power to Mines by Bore-Holes.

According to an article in the *Colliery Engineer*, of October, 1887, a method of conveying power to mine workings was adopted at Shenandoah, Pa., that is susceptible of good use elsewhere. In 1883 the third or lower level of the Mammoth coal seam was pretty well worked out, and it became advisable to develop new workings by an inside slope. As the distance, measured along the gangway, was 6,700 ft. from the foot of the existing slope, it was impossible to locate the engines and boilers at any place except inside the mine, unless bore-holes or a new rock slope was resorted to.

The bore-holes were decided upon as being by far the cheaper and just as convenient; and the boilers and engines, being on the surface, the inside workings would be free from the gas, etc., emenating from them. Points were accordingly marked on the surface on line with the center line of the new slope and the course and distance carefully calculated for the bore-hole.

An 8-in. hole was then bored by the machinery used in drilling in the oil regions. The hole was 244 ft. deep, and when finished was lined with a 5¾-in. casing pipe, with the space between the pipe and the rock filled in with Rosendale cement. Another hole, 6-in. in diameter and 118 ft. deep, was then drilled to the same working; through this latter hole passed two 2-in. pipes to be used as a speaking tube and for bell-wire to the engineer of the surface machinery. Through the large pipe a 1-in. HAZZARD wire rope passed for the transmission of power in hoisting up the inside slope.

Similar bore-holes are now in use at the Philadelphia & Reading mines at Mahanoy City, Pa. At the East Franklin Colliery two 8-in. holes are used, 7 ft. apart, to hoist from a double-track underground slope. At Nanticoke, Pa., similar bore-holes are used for conveying steam and for waterways. At the Lincoln Colliery, an 8-in. hole, 140 ft. deep, carries a 4½-in. steam pipe to an inside pump. At the Meadow Brook Colliery a 12-in. hole with an 8-in. pipe cemented, is used for a column pipe from an inside pump. At the Clear Spring Colliery, at West Pittston, Pa., a 4½-in. steam pipe is carried 270 ft. through a 6-in. bore-hole.

THE Albany ceiling cost $175,000 and the grand stone staircase, $250,000 more. Both were startling experiments, and both are very pronounced failures.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Civil Engineers' Club of Cleveland, O.—Regular meeting, Feb. 28. (Architectural branch of the club). Secy., C. O. AREY, 31 Blackstone Building.

Engineers' Club of Philadelphia, Pa.—Regular meeting, March 3. Secy., Howard Murphy, 1122 Girard St.

Engineers' Club of Kansas City, Mo.—Regular meeting, March 5. Secy., Kenneth Allen, 19 Deardorff Building.

Engineers' Club of St. Louis, Mo.—Regular meeting, March 7. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, March 7. Sec., John Bogart, 127 E. 23d St.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, March 21. Secy., S. E. Tinkham, City Hall.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 260 Broadway, New York City.

Master Car Builder's Association.—Next convention a Alexandria Bay, N. Y.; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reed, Waycross, Ga.

IT is rumored that Gen. NEWTON may possibly resign his office of Commissioner of Public Works under the temptation of an appointment at Washington under the Government. Gen. NEWTON says it would be premature to now make public his intentions. His resignation would deprive New York of a most efficient public official, and we trust that events may so shape themselves that he may remain where he is.

IT has been suggested to us that our note of last week as to the character of the elevated railway structures which are going up in Brooklyn does injustice to the contractors for them, in that they were forced by competition to do not what they would, but what they must, and that, as there was no disposition among the companies to pay for really first-class, solid structures, all the contractors could do was to furnish the best structure which could be had for the money.

It is also stated, and with entire truth, that the conditions fixed by the Rapid Transit Commissioners made it extremely difficult to obtain great rigidity, and impossible to do so without a heavy increase of cost which the companies were *not* ready to incur. These conditions were (1) the posts must be on the curb line, even where the street was very wide, (2) the tracks must be over the middle of the street, and (3) only lattice girders were to be built.

All this we are quite ready to admit, and we know too well how these things go to even attempt in our own minds to apportion the blame to individuals. We simply say that blame exists somewhere, and very great blame. It may well be, and we certainly did not deny, that it would be impossible to put the same money and same material into a structure erected under the fixed conditions, and improve them in any material respect. Nevertheless, the *fact* remains that, whether from folly of the Rapid Transit Commissioners, or from the unrestricted competition enforced by the companies, or from whatever reasons, the Brooklyn Elevated lines, instead of being an advance upon the earlier New York practice, as are the excellent structures which have been erected beyond the Harlem River, are for the most part decidedly inferior to them in the essential elements of durability. This seems especially unfortunate because experience with the New York structures certainly indicates that something better and stronger was needed rather than something weaker and worse. Since the first erection of the New York lines there has been one perpetual process of tinkering and strengthening going on, so that much more has been spent in patching up long stretches of it than would have sufficed in the beginning to erect a thoroughly adequate and solid structure.

That the same thing will happen in aggravated form with a large proportion of the Brooklyn structures, we cannot doubt. The roads will hardly be opened, in our opinion, before trouble will begin, and we shall not be at all surprised if it soon proves very serious trouble. But, as we have repeatedly maintained in these columns, the least guilty party of all for any defects of this kind is the contractor for their construction, even when he has *nominal* liberty of design. Nor are the nominal "engineers" of the line ordinarily to blame for it. Both contractors and engineers, as a rule, know very well what good and solid work is, and infinitely prefer it, if they are given a fair chance to choose between good and bad. The real blame, almost invariably, lies back of both, in men who have temporary authority and love to exercise it, but are without the knowledge to exercise it discreetly, and who will not admit that they need any professional aid to do so, because they cannot be made to comprehend the profundity of their own incompetence. If a man wants to buy a hat, and without knowing much about them or asking advice of any one who does, runs up and down among the hatters seeking merely for "a hat," is the hatter to blame who finally sells him "a hat" for a dollar? We do not think so; rather the foolish man has only himself to thank if his hat finally turns out to be, as it probably will, a "sacrifice of almost every principle of sound construction" in a hat "to cheapness of first cost." The man himself may not have been to blame in one sense, likewise, in that he did not intend to buy a bad hat, but only a good hat cheap, but if he is such an ignoramus as not to know how to buy a hat in a sensible way, he must accept the result of his own folly, and in declaring his hat to be a shocking bad one, the bystander should certainly not be understood to blame the man who sold it to him. He had good hats to sell likewise if the man wanted it, but he did not—enough to pay for it.

THE *Bulletin du Canal Interoceanique* of Feb. 9, declares that because it has ceased to publish, since Oct., 1887, the amount of work done each month, the adversaries of the Panama Canal have assumed that work was practically suspended on the Isthmus. The *Bulletin* answers this charge by stating that the change in plan now accomplished required the presence in Paris of the principal engineers and contractors, and moreover, owing to the enmity shown by many to the general scheme, it was deemed expedient to keep very quiet until all plans were perfected and the new contracts made. These matters are all arranged now and the *Bulletin* crushes the "suspension" rumor by a statement that in the three last months of 1887 a total cube of 2,531,000 cu. m. were extracted,—a very fair average output at any time, and especially good in a bad season of almost continual rain.

WE learn that a very prominent bridge engineer, who claims to have made a careful study of the Forth bridge on the ground, has freely expressed the opinion that there are causes of weakness in that structure, which will make it exceedingly difficult ever to close the cantilevers without much trouble from shearing of rivets and perhaps worse. We should want far more definite evidence than this before we should be much troubled by these doubts, and until such evidence appears we shall confidently expect to see the structure triumphantly completed without any trouble of moment, according to the design; but except that the magnitude of the structure, and the eminence of the engineers connected with it makes it seem impossible that there can be any real grounds for such fears, we should certainly attach great weight to doubts originating from such a source, and we chronicle them merely as a matter of news.

In the mean time we shall publish next week a large view of the present status of this grand work, which we earnestly hope and expect will prove one of the greatest triumphs of English engineering, with further notes as to its present status. The opposite ends of the cantilevers are not yet very far advanced, and although the constructive difficulties will diminish at every step hereafter, from decrease of the dimensions of parts to be dealt with, yet it is needless to say that the structural strains have not yet begun.

The Union for the Improvement of the Canals of the State of New York, is issuing a variety of documents to stir up the people on the subject, and at the close of one of them gives the following striking comparison, which we do not remember ever to have seen made before:

Receipts of Grain in Bushels at Competing Ports During Season of Navigation Compared with Receipts when Navigation is Closed.

	Navigation. Open.	Closed.
Philadelphia	9,774,751	7,896,280
Baltimore	13,542,457	10,532,347
Boston	9,801,771	7,255,291
Three Ports Combined	33,118,979	25,683,918
New York	74,563,509	21,945,663

As the report well says, these figures show the wonderful impetus given to the grain trade of New York by the canals, and demonstrate that the railways alone cannot hold the grain trade against the inducements offered by other routes to competing cities. When navigation is closed this city is behind her rivals, but when the canals are open and directing the current of trade toward her harbor, New York assumes her natural position as the leading grain center of the country.

A comparison of the receipts at Philadelphia, Baltimore and Boston for the year 1887, against 1886, shows a falling off 7,645,148 bushels in 1887. This, together with the fact that the receipts by rail, river, coastwise, etc., at New York also decreased over 8,000,000 bushels, while the receipts by canal increased over 2,000,000 bushels, certainly indicates the vital importance of continuing the improve-

ment of our canals and placing them in the highest possible state of efficiency.

THE Canadian Society of Civil Engineers a year ago and now compares as follows:

	Mem.	Assoc. M.	Assocs.	Students.	Total.
Feb. 24, 1887	163	34	13	68	278
Jan. 12, 1888	225	65	27	106	423
Increase	62	31	14	38	145

It would appear as if this Society was filling a long felt want from its active growth. It is already moving with strong prospects of success, to establish a fund to secure permanent quarters for the Society in Montreal, and also raised its dues materially at its last Annual meeting, which is a good indication of strength. The action taken at that meeting to provide for special Students' meetings is recorded elsewhere, and we must confess surprised us very much, for we should hardly have supposed that in a small place like Montreal it would have appeared possible to have such meetings.

THE amazing proposition to plaster with advertisements the Brooklyn bridge cars for the sake of putting $5,000 or $10,000 in the pockets of this metropolis, has excited such public opposition that we are glad to believe there is no prospect of last week's vote in its favor being carried out. The offense would be greater in degree only, not in kind, had it been proposed to sell out the towers and trusses for advertising use. By letting **SAPOLIO** and **IVORY SOAP** confront each other from the top of the towers. With other decorations in keeping therewith. We have no doubt $50,000 or $100,000 a year might be obtained, and a world-wide reputation beside.

The true objection to this course is not that it treats the public unequally, as the Brooklyn *Eagle* surmises, in a rather unsuccessful attempt to give grounds for its instinctive objections. Selling privileges of any kind to the highest bidder is not discrimination; but the project is in effect to sell not the space, but the eyes of the public, which are necessarily entrusted to them for another purpose for a limited time. In other words, it is selling as one's own goods which have been merely delivered on consignment, which is an act of dishonest appropriation precisely analogous to that of a washerwoman who rents out the clothes entrusted to her for other use while she is supposed to be merely washing them. To suggest that two great cities should go into this kind of business is repulsive to every right feeling person, especially as the revenue gained is a mere bagatelle; $5,000 per annum being only *one cent* a year each for the 500,000 different individuals who patronize the bridge. Who would sell his own eyes to read advertisements for fifteen minutes a day for a cent a year? But what the individual would not do for himself the Trustees have resolved to compel him to do whether or no. The great and only BARNUM tried the same game years ago on the drop curtain of his "museum." He had to give it up, and the trustees had better do the same.

THE "Personal" in this issue in respect to JOHN W. HILL, and his successful resistance of an absurd attempt by a city officer to tie the hands of engineers and diminish their freedom of action, is one worthy of more than passing note, perhaps, but the moral is so clear that we do not attempt more.

The Design of the Quaker Bridge Dam.

II.

It remains to consider the possible contingencies in which a curved dam, *i. e.* one with a curved crest and approximately straight toe, instead of a straight crest dam, might reinforce a deficiency in its normal gravity stability by action as a true arch; any stability thus derived being, of course, in *addition* to the normal gravity stability, which continues unchanged under all conditions until the dam collapses.

An earthquake of any moment has never happened in New York within historic times; —neither had it in Charleston until 1886. "Historic times" on New York island, however, does not run back very far. It was only discovered in 1609, and settled in 1623, or 265 years ago. For much more than twice this period of time Vesuvius had been an absolutely quiescent and apparently extinct volcano, until it burst forth in A. D. 63 and 79. Since then, it has had eruptions about once a century until a hundred or two years ago. Since that again it has had much more frequent erruptions. Lisbon, likewise, had known no earthquake of moment until the great one of 1755. The same year saw a violent earth quake in New England which threw down men and stone walls in the open fields, and many chimneys and buildings. In 1870, and again in 1883 a very decided shake extended all through the northeastern States; in 1811-12 there were violent shocks in the Mississippi valley. In all some 240 earthquakes are on record in New England since 1638. The whole Atlantic coast appears to be slowly sinking, at the rate of about 2 ft. per century, and even before the late Charleston earthquake, was regarded as notably more subject to earthquakes than northern Europe.

The earthquake of 1884 was of but slight severity in New York City but at some points in the northeastern States was much worse than here, and quite severe enough to indicate that worse ones may come at any time.

The description of the earthquake of 1755 is worth quoting more fully:

"The earthquake of Nov. 18, 1755, began in Massachusetts with a roaring noise like that of thunder. After a minute's continuance of this there came the first severe shock with a swell like that of a long rolling sea—a swell so great that men in the open fields ran to seize something by which to hold on, lest they should be thrown down. After two or three lesser shocks there came *the most violent of all, producing a quick horizontal tremor with sudden jerks and wrenches. This continued two minutes*, and after a slight revival died away. Numerous other shocks followed in the course of a month. In Boston the main shock threw down or dislocated and twisted many chimneys, brick buildings, etc., and throughout the country it threw down the wide stone walls bounding the farms"*

The motion described in the italicized sentences is precisely that which would be most trying to a dam, viz, *quick horizontal* motions. The amplitude is of much less importance than the quickness.

These facts are quite enough to indicate the strong probability that a structure built to endure for centuries like the Quaker Bridge dam, may at some time be very severely tried and perhaps destroyed by an earthquake. The probability is of course still stronger of milder earthquakes, which may destroy a comparatively weak dam, but would leave uninjured one which *in an emergency calling for it* might have many times more than its normal gravity strength, while retaining the latter under all conditions.

The accepted theory of earthquakes is that it produces a motion of the solid earth analogous to the wave action of water; that is to say, each particle moves in an elongated ellipse, whose axes depend on the violence of the wave or earthquake action.

Here let us stop right short, and relate a fact showing what a full-grown earthquake can do when it "means business," which has never been in print before, but was related to the present writer by a personal friend who was an eye-witness of the facts a few days after the event.

In Peru, as in other Spanish American countries, churches are frequently built with very heavy main walls and square towers, but with an open belfry consisting of arches resting on four corner pillars, above which massive masonry is continued for some 10 or 15 ft. higher. One such church in a small Peruvian village was so tossed by an earthquake that the tower was thrown upward and sidewise, *turned half round*, and landed on the ground at some little distance from the church and entirely clear of it in tolerably whole condition, and still standing on all four of its corner pillars! If any one feels sufficient interest in the matter we cheerfully undertake to give the exact date and place of this occurrence, which we cannot at this moment do from memory.

No such violent action is to be expected here, but it may be regarded as beyond doubt that a much less violent earthquake than the New England one of 1755, or the Charleston one of 1885, would carry away a straight Quaker Bridge dam completely, if the horizontal motion happened to be normal to it, for the following reasons:

Such motion would for the instant set up a *water-ram* action, analogous to that which takes place in a large pipe when it is attempted to suddenly check the current of water within it. In this case, the pipe would be the solid earth, and instead of water moving within the pipe, with the latter stationary, the water would be stationary and the pipe would suddenly begin to move. That is to say, an earthquake may make the earth move suddenly, but it cannot make a mass of water move likewise; and if the earth should begin to move *up-stream*, we should be attempting to carry the vast mass of water along with it by means of the Quaker Bridge dam.

The result under such conditions admits of no doubt: The dam would lift as if of cork, were it twice as massive as proposed. The horizontal component would for the instant be so great that the gravity vertical component would be as nothing in comparison. If the motion were but small, the mass might settle back again and stand as before, but we have four chances against us: *first*, inertia, which would tend to keep the mass in motion when once started; *secondly*, the hydrostatic pressure of the water admitted under the base, which would reduce the effective weight of the whole mass, to the extent that a film of water penetrated beneath it, in the ratio of 1.5 to 2.5; *thirdly*, disintegration of the mass by cracks; *fourthly*, the return backward motion of the earth, which would enable the water to strike the dam a second blow, by its own motion. It is to be remembered that we are dealing with terrific and unprecedented pressures, the dam being as high as a high church steeple.

In an earthquake of any great severity these destructive forces would be so great that any conceivable gain from arch action would likewise count as nothing, and he would be rash indeed who should assert that the gain from arch action might not prove inadequate, even in a moderate earthquake. We certainly have no thought of doing so. But it appears to us that he would be equally rash who should assert that possible arch action *might* not make all the difference between safety and destruction, and hence is well worth having when it can be had for nothing; as also that it *might* not amount to multiplying the normal stability by 50 or 100 or even 500 at the critical moment, although nothing like that, of course, can be counted on.

This possibility results from the fact that,

*American Encyclopedia, Art. EARTHQUAKE.

as Chief Engineer CHURCH well points out, all our experience with arches is confined within very narrow limits. He says as to this (see our issue of Jan. 14):

"The popular belief in masonry arches to bear great weight and pressure is justified when confined within reasonable limits. But no masonry bridge arch of over 300 ft. [We are not aware of any of over 237 ft.] has been constructed. Beyond that length of span the crushing strains sustained by the voussoirs, exceed safe limits on their mortar joints from the weight of masonry above, without the added load the bridge should carry."

This is incontrovertibly correct as respects any proposition to *rely* on arch action for the primary, normal stability; but, besides the fact that in a dam it is physically impossible to rely on that without being aided by gravity stability, in addition thereto, it is important to remember that there is nothing in our experience to date with ordinary arches to controvert the possibility that a vast monolithic mass of masonry in the form of a horizontal arch *may* not resist successfully horizontal arch strains fifty or a hundred-fold greater than any engineer would dare to count on in designing an ordinary arch; and inasmuch as we have a possibility of indeterminately greater strains than the normal, the bare possibility of indeterminately greater stability, called into action by those very strains, is surely desirable, even if it be not admitted to be a probability.

But we think it is a probability. It is to be remembered that all our stone arches of great span are relatively mere ribbons of stone, because of the difficulty of sustaining the weight of heavier arches during construction by adequate centering. Except for this the limit of arch spans could be greatly increased. Their apparent stability is much greater than the actual, because the spandrel walls and parapets, which satisfy the eye by giving an appearance of more massive strength, really give no more computable stability than if they were replaced by a loading of so much pig-iron. Were the latter done in reality every observer would appreciate, what even engineers do not always remember, that the cause which forbids us to count on more than 10 to 16 tons per square foot of crushing strength is merely inability to ensure fair and even loading of the voussoirs, because of irregular yielding of centering, abutments, and cement joints, with resulting tendency to unequal strains, spalling and distortion. Otherwise, we might load an arch with as great loads as foundations sustain, or 400 to 600 tons per square foot, and if such an arch were sufficiently massive it *might* not crush under less strains than rock sustains under mountains and beneath the surface, which is some 400 tons per square foot for each mile of superincumbent rock, especially if the strain were applied for a few seconds only.

It is to be remembered that all the tables of "crushing strength" in our text-books, for both stone and iron, are entirely delusive, except as indicating reliable minima, which can be counted on under the usual unfavorable conditions. It does not at all follow that because a cube or prism of iron, pressed on its ends only, will not sustain more than so much per square inch without yielding, that the convex surface of a wheel will not sustain many fold more pressure *per square inch of actual contact* without the slightest injurious effect; and some rather absurd technical errors have arisen from forgetfulness of this simple fact. Similarly, because small cubes of stone or concrete will not sustain more than 200 to 800 tons per square foot in a testing machine without crushing, it does not at all follow that a much larger pressure would do harm to great masses subjected to pressure on all sides, nor is it probable.

Therefore we think the chances are very good indeed that even an earthquake of considerable severity, which would carry away a straight dam in an instant, might be successfully resisted by a curved dam which was normally a mere gravity dam like the other; and it certainly seems to us that there is enough constant danger of an earthquake to make it highly desirable to take that chance, even if it cost a large sum to do so, instead of practically nothing.

We saw in our last article that a certain compression of the face analogous to arch action would result from the lateral pressure of the water. Another cause will set up a true arch action of limited amount from the first day the water is let in.

The whole mass is necessarily more or less elastic. However carefully the mass be built, when the water pressure is let on, the top will move over more or less, probably several inches, not from weakness, but elastically. Were the material iron and steel the amount of such motion could be computed in advance. With stone this is not possible, but there will be a chance for some very interesting observations, in respect to it, and it will make it necessary to build even a straight dam with a slight horizontal camber to avoid an unsightly appearance of incipient bulging.

In a straight dam, this motion is resisted only by the back side of the dam, acting, let us say, as a buttress or inclined post some 315 ft. long, while it is *increased* by elastic expansion of the vertical or water side of the dam. In the curved dam, the motion is resisted by *three* forces, first, the buttress aforesaid, and secondly by the two halves of the arch, each some 425 ft. long. The result is, first, to reduce the total elastic motion, since it is opposed by greater forces, and secondly, to throw true compressive arch strains throughout the vertical joints as a condition of any elastic motion whatever taking place. A study of the dam as an elastic mass will indicate, we think, that this action must be very considerable, after making due allowance for the fact that the joints have quite different resisting power horizontally and vertically, since they are compacted by gravity vertically during construction, but not horizontally. We may add that for that very reason it is desirable, from the constructive stand-point, to introduce as early as possible horizontal forces to have the same conservative effect on the vertical joints as gravity has on the horizontal.

The nature of the advantage which a convex dam has over a straight one may be appreciated by reflecting on the disadvantages which a concave dam would have. In a convex dam, all motion due to the pressure tends to close the joints; in a straight dam, there is no measurable tendency either way *on the face*, but a tendency to open in the back; in a concave dam the joints tend decidedly to open on both front and back. There will probably be no dispute that an engineer would be crazy who should propose to build a concave dam, and that its chances of standing whole for a single year would be poor indeed. We fail to see why it is any more justifiable, from an engineering point of view, to throw away the advantages of the convex form than to deliberately incur the disadvantages of the concave form.

Analogous strains to those resulting from an earthquake, but on a smaller scale, would result from the malicious use of dynamite. It is needless to dwell on the probability of there being men vicious enough to attempt this if they thought they could succeed. Events have too clearly shown that the class tends rather to increase who would do it from mere brutal recklessness, and the very magnitude and prominence of the work would increase its danger, for the same reason that particularly high bridges and towers are a favorite place for suicide, and that particularly prominent persons are in especial danger from cranks.

All the possibilities which have been here discussed seem particularly important to provide for from the fact that, with a natural and laudable desire to reduce the cost of this great work as much as possible, it is proposed to take advantage of past successes by giving it a somewhat lower coefficient of stability than that of any other great dam in the world, and a much lower one than the average. It may be entirely defensible and proper to do so, despite the fact that a failure of this dam would certainly lead to more serious consequences than that of any other in the world, in loss of life as well as otherwise. But in doing so it is certainly demanded, *first*, to so dispose the mass as to make it as safe against *all* contingencies as possible; *secondly*, to make it architecturally as well asmechanically as correct as is possible without material increase of cost, so that it shall not only BE safe but LOOK safe; *thirdly*, that there should be no especially weak place in the normal cross-section. In respect to the two latter points it appears to us that there is still something to be said, for which, however, we find that we cannot take space this week.

The Facts as to the Student Grade of the Institution of Civil Engineers.

When it first became apparent at and just before the Annual Meeting of the American Society of Civil Engineers, that there was to be opposition headed by two officers of the Society to the addition of a third probationary grade of "Students," with a proposed raising of the qualifications for the two present grades above them, the editors of this journal determined to do unofficially what it seems clear to them should have been done officially by the Board of Direction, rather than allow so influential a fraction of their own body to take the course which they did to suddenly bring out an entirely one-sided expression of views on the eve of the Annual Meeting; viz.: to obtain a few *facts* to lay before the membership as to the results of actual experience, on an immense scale, with precisely similar grades in the leading Engineering Society of the world.

We therefore addressed a letter to Mr. JAMES FORREST, Secretary of the Institution of Civil Engineers, making a number of specific inquiries as to what had been the experience of that body in respect to its present grades, especially the Student grade. To these inquiries Mr. FORREST has been kind enough to reply very fully and completely, by his own hand, in the following response, which we commend to the attention of those who are more interested in the results of large experience and careful study and observation than in merely personal views which are certainly not based on the one, and in but few cases can have been based on the other. We had hoped that a response might be received in time to send out to members before the ballots were sent out which are to be canvassed on March 7, but this was not to be. There are probably but few members who have not already cast their ballots; but the letter will be read with general interest nevertheless, and if by any chance the amendments should not carry this year by the necessary two-thirds majority, as we fully expect they will, it will prepare the membership to vote more intelligently and more wisely another year, when they are pretty sure to again have opportunity to do so.

The nature and scope of the questions addressed to Mr. FORREST are so clearly indicated by his numbered responses that it does not appear necessary to reprint them here. Suffice it to say that they were framed so as to bring out to the fullest possible extent the exact facts of prior experience as to every difficulty or objection which had been suggested by any one, and that the last question asked was a general one as to whether any difficulty or objections *of any kind* had arisen within the Institution from the existence of the Student grade, and as to whether there was any opposition or objection to it whatever. The following is Mr. FORREST's response:

THE INSTITUTION OF CIVIL ENGINEERS.
25 *Great George Street, Westminster, S. W.*
Feb. 9, 1888.

Dear Sir:

In answer to your letter of the 21st ultimo relative to the origin and working of the class of Students of the Institution of Civil Engineers, I have to say:—

First: The establishment of a grade within the Institution for engineers under the age prescribed as a *minimum* for ordinary Members and Associates—namely, 25 years—was effected in 1833, when a class of "Graduates" was formed. The Graduates had to be more than 18 years of age, and they had to submit a drawing, or specimen of their own work as a qualification of fitness. They were elected by ballot in the same way as the Members, and they had full corporate privileges. There was no limit to the duration of their graduateship, although the spirit of the By-law relating to their election pointed to their transfer to the higher ranks as soon as they became qualified by age. This arrangement was not found to work well, and after the class had existed about nine years no more elections were made into it, although it survived until the year 1867.

In June, 1867, the "Student" class, as it at present exists, was established; being a revival of the older organization, but with very important modifications and limitations. The Students do not form part of the body Corporate of the Institution, nor are they elected by ballot, but are admitted at the pleasure of the Council, and are liable to be removed from the list at any time should such a proceeding be deemed advisable. The privileges of Students will be found fully set forth at page 46 of the Charter and By-laws, of which I forward a copy. I may add that there are now about 1,000 Students on the books, and 2,700 have been admitted since the class was established, and no case of misconduct of the slightest description has ever occurred.

Second: So far as I am aware, there was nothing that could be called active oppposition to the establishment of the class, although the matter was for a considerable time under discussion before a decision was arrived at (See Vol. XXVI, p. 123 *et seq.* of the Minutes of Proceedings of the Inst. C. E., in library of American Society of Civil Engineers.) Some few of the older members may have looked askance at the innovation; but if any feeling of the sort existed it was not openly expressed, and has long since died away.

Third: There is no opposition now to the grade, and it is felt to be most advantageous to the Students themselves, and indirectly to the whole Corporation.

Fourth: A considerable number of the Students resident near London attend the ordinary meetings, of which they constitute rather more than one-sixth of the average attendance.

Fifth: The attendance of Students at the ordinary meetings has in nowise been found annoying or inconvenient to the members.

Sixth: The special supplemental meetings for Students only are fairly well attended. The numbers in attendance vary within small limits—the average being about fifty.

Seventh: I have never noticed, nor heard of others noticing, boyish or indecorous behavior on the part of the Students when at the Institution. The large proportion are young men of full age, and any disposition on the part of the juniors towards conduct of that kind would, I think, be immediately checked by the example of their older comrades.

Eighth: About one-fourth of the Students may be said to hold certificates of some technical College or Engineering School, and the proportion is increasing. The possession of such a certificate does not, however, in itself, constitute a qualification, as the candidate must be either a pupil of, or an assistant to, the Corporate Member of the Institution who proposes him. Of late years, the Council have exacted a certificate or testimonial that the candidate is qualified in the subjects of general education; but this is independent of any technical certificate or degree.

Ninth: There being, with us, no distinctive classes such as are implied in this question, and the necessity for "controlling" the behavior of Students never having arisen, I am unable to answer.

[The question was as to whether there was any difficulty in controlling the behavior of the Student class, to prevent annoyance to Members, etc.]

Tenth: Undergraduates of technical schools are admitted, if they are proposed by a Corporate Member, and have the proper qualification as stated in answer No. 8, but not otherwise.

Eleventh: The proportion of Students who drop out of the Institution by age limitation, or other causes, and thereafter cease to be connected with it in any way, is almost exactly one-third.

Twelfth: The connection with the Institution is highly valued by the Students, and I apprehend that the great majority join the class spontaneously, although in some cases the advantages of Studentship may have been first made known to them by the engineers under whom they are serving. Within that limited sense, accession of Students may be influenced by their superiors; but I am satisfied that no pressure is ever brought to bear to make them join the class.

Thirteenth: In general, the working of the class has been in every way satisfactory, and suggestions are constantly made for the extension of its usefulness.

As bearing on this question I send by book post copies of

a. Charter and By-Laws.
b. Reports of the Council for 1877, 1884 and 1886, containing references to the working of the Student-class.
c. List of Members.
d. Subjects for Papers, 1887-88.
e. Selection of Papers by Students that have been deemed worthy of being printed in the Minutes of Proceedings of the Institution.

The marked pages in documents *a* to *d* will show more fully the privileges attaching to Studentship, and the series of original Papers by members of their grade, will indicate the class of men who seek to avail themselves of the advantages held out by such connection with the Institution.

Although not included in your inquiry, I may mention that the Students residing outside the Metropolitan area have in several cases, where sufficiently numerous, formed local Associations. Such bodies exist at Liverpool, Glasgow, Manchester and Birmingham. There meetings are held for the reading of Papers, arrangements made for visits to engineering works, and, in fact, there is carried on locally, work similar to what is done for the Students in London; but these local Associations are not directly under the control of the Institution. These organizations appear also to have successfully fulfilled the objects for which they were formed.

I shall be most happy to answer any further questions, and to afford you every information in my power, in this or any other matter.

I am, dear sir,
Yours faithfully,
JAMES FORREST, *Secretary.*

In view of such a response from the man who should be by far the best qualified of anyone in the world to express a decisive opinion in the matter, we should judge that no further answer would ever be required to various of the objections which have been brought forward on individual responsibility. At any rate, as it would be impossible for us to add anything to the force of Mr. FORREST's letter, we shall not attempt to discuss them further, except to add one fact bearing upon the sole argument of *prima facie* force which has been brought forward to discredit the indications of English experience, viz., that conditions in the two countries are so radically different that measures which have been a great success in England will be a total failure in this country.

We have no belief in the soundness of this position: Blood is thicker than water, and while environment may make a superficial difference, yet the nature beneath is the same, so nearly so that after two or three years of common residence, and often without it, it is no easier to tell the Englishmen and American apart than the Eastern and Western American. But even if this be not admitted as between England and America, it is certainly true as between Canada and America, since the colonial condition of Canada is a mere sentimental tie, and it is nothing in fact but a smaller United States, in blood, in origin and in social and professional conditions. The experience of the two-year old Canadian Society of Civil Engineers has therefore a direct bearing, so far as it goes. By a majority of 98.1 per cent. of the votes cast at the last Annual Meeting of that body, this provision was added at the end of By-Laws 38.

"*Students' meetings* shall be held at 8 o'clock in the evening, at such dates as shall be determined by the Council, and of which due notice shall be given."

If a little place like Montreal, in a little country like Canada, contains enough embryo engineers, who have joined the Canadian Society as Students, to make it seem necessary to amend the by-laws so as to provide for special Students' meetings, it is hardly a tenable position that there will not or *may* not be ample material within the American Society for a similar end. Any provisions which are found to fill a real need in both the English Institution and Canadian Society, may surely be counted on with some certainty to fill a real need here, if they are given a fair change.

The pending amendments for the reorganization of grades in the American Society of Civil Engineers have not gone out in exactly the shape which we should desire, and in one respect especially they are in very objectionable shape, viz., in fixing the names of the three grades as Member, *Junior* and Student, instead of as originally proposed, Member, *Associate Member* and Student. The worst objection to the name of Junior in the past has been that it was generally assumed to indicate a lower grade of experience than it really did, or little if any more than the English Student grade. Junior members of the Society who have been abroad have in instances found this quite embarrassing. Had the term Student instead of Associate Member, been changed to Junior, in fact, it would be a fairly appropriate term, and there would have been no particular objection.

By the new amendments, however, the qualifications for the Junior grade have been made nearly as high as they have been heretofore for a full Member, while the creation of a still lower grade makes it entirely absurd to call the *intermediate* grade Junior, especially as it may be expected to contain a considerable number of men who will never attain the relatively high grade of qualifications which will be hereafter required for a full Member, if the amendments pass. The change back from Associate Member to Junior was hastily made at the Annual Meeting, without proper discussion, and chiefly by the votes of those who were known to be willing to defeat the whole measure, nor can we doubt that it was voted for largely with the express intent of de-

creasing the chance of its passage, as it no doubt has done.

This and any other minor defect is easily corrected later, however, if the amendments pass; and we trust that no Member who has not yet voted will allow them to influence his actions.

The Boston Water Meter Tests.

The Boston Water Board has at last made public a synopsis of the extensive tests of water meters commenced in that city in April and concluded in Oct, 1887. The commission to make the tests were Messrs. L. FREDERICK RICE, CHARLES CARR and N. M. LOVE, and this commission has now completed its report.

The avowed purpose of this test was to "supplement the experience of the department by such well-founded information, obtained through impartial and competent channels, as will enable them (the Water Board) to avoid the wasteful experiences of the past and to secure the best available machines for the use of the city, whether the demand be large or small."

Of the 35 machines entered for the test 26 were actually placed on the testing bench. The first series of tests showed the following results:

FIRST ACCURACY TEST.

The sign—before figures of percentage indicates registration of less water than actually passes. The blank indicates the contrary.

	ERROR OF METER.					RETARDATION.		
	Minimum per cent.	Maximum per cent.	Average per cent.	Range of per cent.	No. of Experiments	Friction per cent.	Flow decreased per cent.	Time increased per cent.
Ball & Fitts	—1·2	1·1	0·3	2·3	37	44·4	23·9	31·4
Balance Valve	—1·9	6·8	2·8	8·7	36	47·1	12·3	14·6
Crown	—0·2	2·2	1·3	2·4	36	41·2	14·6	17·1
Desper	—2·6	0	1·1	2·6	27	71·7	38·9	64·0
Duplex	—2·9	1·4	0·3	4·3	37	47·8	21·9	28·9
Eagle	—3·6	6·7	3·7	10·3	30	61·1	31·4	52·6
Empire	—2·2	1·3	—0·7	3·5	36	35·3	11·0	12·8
Equitable	1·0	2·9	2·0	1·9	37	67·9	38·7	64·0
Frost	—0·3	3·6	1·1	3·9	37	52·9	29·7	43·2
Hersey	0·9	3·0	1·5	2·1	37	53·0	23·9	31·8
Hood 1, No 1	0	2·1	1·0	2·1	37	61·1	28·4	40·1
Johnson	—5·0	13·7	—1·1	18·7	37	75·0	48·4	92·8
Shedd	—0·8	0·8	0	1·6	36	34·4	34·2	51·6
Spooner	—3·8	3·0	—0·5	6·8	37	52·2	27·1	37·6
Standard	—6·8	6·2	3·0	13·0	36	80·0	54·8	122·1
Star No 3	—0·4	2·6	0·4	3·0	37	36·7	16·8	20·3
Star No 9	—7·3	2·7	—1·0	10·0	27	4·32	13·6	16·1
Terry	—2·7	1·3	—0·6	4·0	37	52·9	28·4	39·8
Thomson	3·6	14·2	6·8	10·6	37	41·2	14·8	17·4
Tremont	0·9	14·2	5·2	13·3	37	61·5	30·3	43·3
Tuerk	—1·8	0·7	—0·3	2·5	35	24·3	7·2	7·8
B. W. W.	1·8	9·5	3·8	7·7	37	52·9	20·8	26·2
Worthington impr'd	—0·1	4·9	2·4	5·0	36	36·8	10·3	11·6
Union Rotary	—2·9	1·3	—1·2	4·2	37	25·0	8·2	8·5

Following these tests the meters were given a continuous run, subject to slight daily interruptions, for from 15 to 20 days, entailing a duty equivalent in amount to the average duty performed in two years' time by meters in the Boston service. Several of the meters failed to stand this test either from structural defects or weak construction, and they do not appear in the summary of results secured in the second trial of accuracy, which is as follows:

SECOND ACCURACY TEST.

	ERROR OF METER.					RETARDATION.		
	Minimum per cent.	Maximum per cent.	Average per cent.	Range of per cent.	No. of experiments	Friction per cent.	Flow decreased per cent.	Time increased per cent.
Ball & Fitts	—8·1	—10·4	—9·2	2·3	8	59·3	27·1	37·1
Balance Valve	—1·0	—5·8	—3·8	4·8	8	42·9	16·8	20·5
Crown	—0·8	—3·0	—2·0	2·8	8	38·1	10·3	11·6
Duplex	—4·7	3·2	—1·1	7·9	8	47·8	20·6	26·7
Empire	—1·9	—6·3	—3·5	4·4	8	28·2	6·8	7·5
Eq'table	—0·3	—1·9	—1·1	1·6	8	64·9	34·8	53·7
Frost	—0·3	1·8	0·5	2·1	8	50·0	23·9	31·1
Hersey	—1·5	—6·0	—4·0	4·5	8	50·0	18·7	23·5
Hood 1	—2·6	—4·8	—3·9	2·2	8	56·5	25·2	36·0
Shedd	—1·4	1·8	1·7	0·4	8	50·0	8·5	9·3
Star 8	—2·3	1·2	—1·2	3·5	8	36·8	12·3	14·1
Terry	—24·4	—43·7	—43·7	19·3	8	43·4	14·2	16·8
B. W. W.	—2·1	7·6	3·1	9·7	8	50·0	20·6	26·6
Wor'h'n-ton improved	—1·9	9·5	2·7	14·4	8	41·2	14·2	16·8
Union Rotary	—20·3	—8·8	—12·8	11·5	6	25·0	7·1	7·9

The Commission then reviews the positive failures and the meters which have peculiarities which prevent their approval. The approved meters are classified into three groups, as follows: The Crown, Hersey and Shedd rotary meters; the Union Duplex, "B. W. W." and Worthington improved horizontal acting, double piston meters; the Frost, Hood No. 1 and Star vertical acting, slow moving, single piston meters.

They say the Crown meter "operates with freedom and has but little range of error, either before or after continual wear. Its principal defects seem to be the possibility of being stopped by small particles of solid matter interposed between the piston and the case, and the harmful effect of hot water upon the hard rubber piston." In the Hersey meter the range of error is said to be somewhat less than in the Crown, but the effect of wear on the piston is somewhat greater. The Shedd bi-lobe meter is said to be the most accurate of all the meters tested; it is very simple, of small size and cheap. The commission commends it but recommends caution until it has been tried to a greater extent than at present.

The Union Duplex meter is recommended as showing but slight signs of wear; the "B. W. W." not being made by the original makers, the Worthington Co., showed careless workmanship and bad material and was erratic in its actions. The Worthington Improved meter used excellent compositions; the valves were somewhat worn, but very uniformly; "a little more expense would produce an excellent machine." The other meters were dismissed with but little comment in the synopsis of the report presented.

The report, in fact, though conducted at great expense developes nothing that was not hitherto known to the majority of water-works Superintendents and to Engineers throughout the country. It practically endorses the meter that had the approval of the Water Board previous to the advent of the notorious "Tremont" meter; and the "B. W. W." meter which has been looked upon as a successor of the "Tremont," is very properly damned by faint praise. This "B. W. W." is a cheap imitation of the old Worthington meter in those parts upon which the patents have expired; and 328 of these machines were purchased by the city last year at a price which we understand is several dollars more on each than would have been paid the original Worthington makers for a much better article in material and finish. Boston reports say also that the actual working of the "B. W. W." proves the wisdom of the Commission's lack of endorsement. The report and the experience that brought it about is an endorsement of the Board of 1883 (Messrs. CUTTER, SAWYER and STANWOOD), which was removed for "inefficiency"—to be succeeded by a Board that bought the Tremont meters now offered for sale as old junk.

CORRESPONDENCE.

"Students" and "Juniors."

DENVER, COL., Feb. 13, 1888.

EDITOR ENGINEERING NEWS:

I do not know that I can add anything to what has been already so well said in ENGINEERING NEWS, in favor of the Student grade of the American Society of Civil Engineers. Yet I may cite an instance where the "Junior" grade militated against a gentleman joining the Society. Hence I prefer that the Junior should be designated as an Associate Member. The case is now before the Board of Direction, and they thought the statement supplied was insufficient for qualification for full Member; hence advised a Junior. The candidate refused to become a Junior, but I am confident would have been quite content as an Associate Member.

I know very many young men, able, clever and who in time will become bright engineers, desirous of joining the Society. The Junior grade is too high, and hence the young men are debarred, and I believe that the Society suffers from their loss.

Yours truly, M. J. B.

Traction Increasers and Bridge Strains.

DELHI, O., Feb. 1, 1888.

EDITOR ENGINEERING NEWS:

A few months ago I had occasion, on a road with which I was then connected, to look up some features of the strains to which its bridges were subjected, and the result of my investigations gave figures that differ materially from those with diagram of rolling loads usually taken as standards, especially as to the concentration of the weights in the heavy passenger locomotive.

These were weighed by the designer and builder, and to the weight of the engine, 90,600 lbs. was added the weight of the loaded tender, 65,000 lbs., distributed not conspicuously different from distributed weights of a number of locomotives. But these engines are equipped with "Dee's Traction Increaser," by which part of the weight of the tender, and of that on the forward truck is thrown on the drivers, and the effect of this device to modify the loads is shown in the following table of loads on each wheel with or without the device in use.

	Without.	With.
Truck wheels	15,800 15,800	11,800 11,800
Drivers	29 500 29.5 0	42,500 42,500
Tender wheels	16 250 16,250	6,500 6,500
Tender wheels	16,250 16,250	17,0 0 17,000

I. e., there was 85,000 lbs. on a base of 8 ft. 6 ins., with a possibility of a greater load. I have seen no reference anywhere to provisions for these shifting loads, and the representatives of one or two leading bridge companies have spoken of these weights as new in their experience. As they were introduced on the road mentioned by one of the best master mechanics, it would be interesting to know to what extent these appliances are used and provided for in bridge designs, and to know the effect of their use, on, say, a Pennsylvania Railroad passenger engine weighing 112,000 lbs. with 640,000 lbs. in the tender.

W. W. RUGGLES.

[The traction increaser is in every way a commendable and desirable device for certain kinds of service especially for passenger service. It would be used still more than it is now, if due attention were paid to economy, and its use is likely to increase. The better class of specifications now provide for 40,000 lbs. per axle, but many do not, and it is liable any day to be exceeded; in fact, ought to be for operating economy as an aid to starting trains. Our correspondent's letter is only another evidence of the folly of computing bridges for specific wheel-bases, a practice which, we are glad to say, is passing out.—ED. ENG. NEWS.]

An Engineering Code of Ethics.

PITTSBURG, Pa., Jan. 25, 1888.

EDITOR ENGINEEEING NEWS:

In your issue of Jan. 21, I was interested in an article on "Division and Resident Engineers." You regret that there is no sufficiently well established code of professional ethics in engineering. I have for some time thought that if a code of ethics for engineers could be formulated, it would be a good idea, and is it not possible that this committee of the American Society, or another one, might take this subject up, or is it not possible that your paper might. Can you not do it?

In your monthly reports of wind velocities, etc., can you not give us an idea of the pressure per square foot of surface exposed, at the different velocities? I find that the authorities, so far as I am able to judge, differ somewhat as to the relation of pressures to velocities.

Yours very truly. J. H. HARLOW.

[The capabilities of the American Society of Civil Engineers, and especially of committees of that body, for doing nothing in such matters as that suggested by our correspondent are vast and profound. Our correspondent is a member, however; and we cordially invite him to make the experiment. It strikes us that the first necessity for a "code of ethics" in any profession, is a definite line of demarcation by which to determine who does and who does not belong to it. Until we are much nearer to that end than we are today it seems useless to even attempt to proceed to Article II of the code. We have done the best we can to aid in establishing Article I by urging such a reorganization of the present absurd membership grades of the Am. Soc. C. E. that the fact of connection or non-connection with it shall serve as such a line of demarcation. The ballots on the amendments to this end are now out, and after it is clear that Article I is in a fair way of establishment, we shall be happy to aid toward Article II.

We can give no exact "idea of wind pressure per square foot at different velocities," because we have none; neither, so far as we know, has any one else, though perhaps some think they have. ED. ENG NEWS.]

The Action of Salt Water on Wrought-iron Piles.

WASHINGTON, D. C. February 14, 1888.

EDITOR ENGINEERING NEWS:

Your correspondent Mr. FRANCIS (issue Feb. 11, 1888, page 101) desires the result of observations on the action of salt water on wrought-iron piles. A few years ago I made quite a number of observations on the action of salt water on wrought and on cast iron piles that were used as the foundations of light houses, and I cheerfully give the results, though they may not be of any great value.

These light-houses were built all along the coast from Delaware Bay to Texas. I found that in all cases wrought iron deteriorated more rapidly than cast-iron. That the corrosion was greatest between high and low water mark, greater at high than at low water, and greater immediately above high water than under low water. That below low water the piles soon became covered with a coating of marine shells, which served to protect the iron. Indeed when this coating of shells was removed, the iron was bright and unaffected. Five inch wrought-iron piles that had been down for 20 years had been reduced in diameter, in some cases as much as one-half an inch. In other words some of the piles had only an effective diameter of four and one-half inches at the end of that period.

Wrought-iron piles that had suffered such deterioration presented a curious aspect. In some cases the corrosion had been in deep lines, giving the pile the appearance of a bundle of wires of various thickness that had stuck together. In other cases the corrosion was in spots, causing indentations like small-pox marks on a man's face.

I have never seen any cast-iron piles that had become soft as some kinds of cast-iron do. Cast iron, when covered up in the mud at the bottom of a bay or inlet of the sea, does not seem to deteriorate at all.

Very respectfully,

PETER C. HAINS.

[Mr. THOS. M. CLEEMANN, late President of the Engineer's Club of Philadelphia, refers Mr. FRANCIS to the paper by Mr. EDWARD PARRISH on "Effect of Sea-water on Iron at Brandywine Lighthouse, Delaware Bay," found in the Proceedings of that Club for August 1884, p. 129. The lighthouse was founded on screw-piles of hammered iron, 5½ ins. in diameter, and was built in 1849-50. An examination was made by Capt. M. R. BROWN, U. S. Engineers, in 1873. He found a decrease in diameter, in some places, to 4¾ ins. and 4⅝ ins. Some of the piles were of rolled iron, and these showed a decrease of .01 in. in diameter per annum; while the greatest reduction in the rolled iron was .035 in. per annum. The most serious corrosion was below the low-water mark, in 6 ft. of water. The piles were seamed in the direction of their length; one hole was found 2 ins. deep and 1 in. wide; another hole was 4½ ins. long and 1½ in. wide and deep. Some of the cast-iron sockets were found coated to a depth of ⅛ in. with a dark gray coating of metamorphosed iron, soft enough to be removed with the finger-nail. Above high-water mark the piles suffered no appreciable reductions of diameter, though probably wet every day. But the diagonal rods above water were much rusted and scaled.—ED. ENG. NEWS].

German Train Resistance Tests.

HANOVER, Germany, Feb. 7, 1888.

EDITOR ENGINEERING NEWS:

In your issue of Dec. 10, 1887, page 421, there is an article entitled, "Some Needed Train Resistance Tests," from which I infer that the author is not aware of late tests which have been made in Germany concerning the resistance of railway trains. In consideration of the interest which is taken in your country, in this matter, I take the opportunity to give you the following reports:

In the years 1879 and 1880, I made several experiments on the railway tracks of the Alsace & Lorraine railways; concerning the resistance of the locomotive and trains. For these experiments, the stretch of track selected, 9 kilometers long with a rise of 0.5 per cent. in grade, was very favorable, because locomotives of passenger trains as well as freight trains reached resistances which almost equalled the velocity, due to the grade and weight of the train. The magnitude of the impetus (moving force) was given with mathematical precision, and possible errors in respect to it eliminated, which would have been possible by other methods. If, at a certain velocity, resistance arose from the resistance of the train, the propelling and resisting forces finally became equal, and mathematical precision was attained. The change of speed, which took place before the reater resistances set in, was owing to the inequality of the two forces, but by having the test track sufficiently long for uniform speed to establish itself, it was seen with what regularity the resistance changed with the velocities.

After I had determined the resistances, during the run of a locomotive and train, and also determined the resistances of a locomotive and train using steam, I wrote an article for the *Organ für die Fortschritte des Eisenbahnwesens*, 1883, Nos. 1 to 3, in which the laws of movement and the important coëfficients determined by the experiments were shown graphically, agreeing well with each other. This article found favor in Germany and other countries, and it won a prize of 1500 marks from the "Society of German Railways," and it appeared in Wiesbaden in *Kreidel's Verlag* in 1885. These experiments of mine have been later reinforced by those made in 1885 on the railways of Prussia, developing the greatest capacities of the locomotive, on different up and down grades at different speeds; an important matter which was fully discussed in the "*Organ*." From all these trials, we have determined important laws about train resistances as affected by speed which I explained in the same copy of the "*Organ*."

The determination of these laws, in connection with my tests on the resistance of locomotive and trains, ha led me further to call attention to the question of the most profitable speed of freight trains, as also to that of the financial cost of grades and curves on railways, as affected by volume of traffic, etc. This was published in the *Organ für die Fortschritte des Eisenbahnwesens* in 1885, page 165, and 1887, page 209. As I take it for granted that all this will find favor and interest in your country, I take the liberty of submitting these explanations to the editor to use to the best advantage.

Yours truly,

ALBERT FRANK.

Prof. of the Technischen Hochschule.

[We shall publish shortly an abstract of the article sent us by Prof. FRANK, and shall then refer to the subject matter of his letter again. While we apprehend that his tests and deductions are among the most correct existing as to this matter, they do not seem to us on cursory examination to cover fully the "needed" ground, even without considering that they are not for American types of rolling stock.—ED. ENG. NEWS.]

The Proposed Bureau of Harbors and Waterways.

CHICAGO, Feb. 20, 1888.

EDITOR ENGINEERING NEWS:

In your editorial of the 18th inst., it seems to me that you have fallen into grave error in regard to the scope and intentions of the bill for the creation of a Bureau of Harbors and Waterways. You seem to assume that promotions are to be made solely by seniority, when Section 6 expressly says: "*Provided however*, that such senior officer in the grades of First Assistant, Second Assistant and Cadet Engineers shall be recommended for promotion by the Examining Board herein provided." The rules and regulations to govern examinations and promotions, are to be formulated by the Commission provided for in Section 12.

Most of the criticisms thus far made arise from the fact that the bill does not go fully into details. It was the intention to provide for the initial establishment, and define the principles under which the final organization should be worked out, leaving the endless detail in regard to promotions, examinations, discipline, disbursements, etc., to be formulated by the Commission, and from time to time by the Central Board, thus allowing some latitude for growth and adaptation. This will, in the greatest measure, avoid the danger of a cast iron enactment.

The bill limits outside entrance to the corps to grades below that of Division Engineer. This is the first grade of definite responsibility, and of comparatively small number, corresponding measurably to the present District Engineer on river and harbor work. It will not be wise to admit entrance to this grade except by promotion from a lower grade, as a full experience in the duties of the corps is a necessary prerequisite for a proper administration. Entrance to this grade is made on proper tests of fitness.

Promotion from the grade of Division Engineer to that of Department Engineer, is wholly by seniority. It is assumed that to maintain a proper standard in the corps, the greatest care will be exercised, in promotions to the grade of Division Engineer, and that any man who attains this rank will, in due course, be fitted for the position of Department Engineer, the duties of which are almost wholly administrative. Below it, all projects originate, and above it is a final board of revision. Perhaps it might be wise to make the Associate Chiefs selective, although this is a matter that has developed some difference of opinion.

From the tenor of discussion thus far, I judge that the provision for promotion by seniority on the recommendation of an Examining Board will best meet the views of those who have given much study to the matter. Good discipline and common justice would seem to require that the senior officer be promoted if he be properly qualified, and such qualifications must be submitted to tests. The wisdom of leaving the matter wholly to the individual discretion of superiors is very doubtful. The Executive Board is, however, desirous of obtaining all views on this and other points, and especially requests correspondence upon the provisions of the bill. The forthcoming report of the Board will set forth the reasons which have led to the several provisions.

You voice the wish of many of our correspondents in desiring that the proposed legislation should take broader grounds. This was an original purpose of the Council and is still its object when wider action shall seem expedient. You will doubtless recall the long and patient investigation, extending through two years, of a joint committee of Congress, some three years since. Its purpose was to coordinate the various scientific Bureaus of the Government, but the results failed to meet expectations and the reasons therefor are apparent upon reading through the vast mass of very valuable testimony.

It became apparent that with some changes in minor matters, each bureau was quite satisfied with the arrangements by which its personnel had attained the present status; that any wholesale change would be unwise, except upon the most careful and detailed consideration which the committee was not prepared to give, and that until each bureau was reorganized with a common purpose in view, any coordination and co-operation of real value was very doubtful. It was apparent also that any movement for a really valuable change must come from the outside.

In regard to such matters no legislation can be seriously or wisely entertained except upon the most comprehensive study. The council has decided to devote their first efforts to one feature only and that the one of perhaps greatest difficulty. Thereby it is hoped that other bureau changes may be made clearer and easier and their mutual relations more evident. Some of them are, or should be, very closely related to the Harbors and Waterway Bureau. This seems to be a matter of detail change in each bureau and of final coordination in a department.

The Executive Board, after considering the very great tax on its energies in arriving at sound conclusions and in promoting the present movement, is satisfied to rest the case until the single purpose is accomplished. Meantime, scientific and other organizations should engage in the studies which should precede legislation for the other bureaus. After the immediate object is accomplished, if it should be the will of the societies, doubtless the Council will continue and make the studies necessary and promote the legislation deemed wise to coordinate the labors of those bureaus most nearly related to that for harbors and waterways. Very respectfully,

L. E. COOLEY,

Pres. Council of Eng. Soc. on National Works.

[We gave our honest opinion of the bill as presented and criticised certain features that seemed to stand in the way of the full success of a much needed reform in administration. The problem is an exceedingly difficult one, with many complications, and we, perhaps, failed to do justice to Mr. COOLEY and his associates for presenting in as good a form as they did the first move in this matter. But the first move in a case like this is the all important one; and while the detail of an organization can be adjusted after the passage of a bill, there are a few ruling elements that had best have their foundation in the bill itself, in substance at least, if not in exact method. We agree with Mr. COOLEY that it is often best to do but one thing at a time; but in this case the "one thing" represents the interests of a most deserving but somewhat limited class, and it is a serious question whether they can enlist a sufficient amount of sympathy from Congressmen, and from brother engineers *not* in Government employ, to bring about any definite and immediate result. The bolder move of embracing all technical bureaus in the reorganization scheme would require more power to put it in motion; but it would also interest and enlist a much greater number of advocates, from the greater public interests at stake; and in providing for the general gain, the individuals would be cared for as well. This is one of the cases where the longest way around is probably the shortest way home.—ED. ENG. NEWS.]

The First Kansas Railway, and River Erosion.

HILLSBORO CENTRE, N. H., Feb. 14, 1888.

EDITOR ENGINEERING NEWS:

The first railroad work done in Kansas in the Missouri river bottom opposite St. Joseph, Mo., was a proposed extension of the line of the Hannibal & St. Joseph

R. R. westward—and its projectors expected it to be the initial section of the Pacific R. R. It was begun in a feeble way by St. Joseph men, and on April 23, 1860, notable as the date of the Democratic convention at Charleston, S. C., about a third of a mile of track having been laid, a locomotive and two flats were taken over the river and the road *opened* amid spread eagle speeches from local Missouri politicians, stimulated by plain Kentucky whiskey, and winding up with a collection of 50 cts. a head for the ride, in which the writer participated. The rolling stock, kindly loaned by the Hannibal & St. Joseph R. R., was returned shortly after, but I do not now remember if the rails, obtained in the same way, followed it back across the river or not. The uncertainty following the disruption of the Charleston convention gave the people of St. Joseph food for thought in a different direction, and the raising of a rebel flag over the U. S. Post Office in April, 1861, resulted in extinguishing their hopes of the Eastern terminus of the Pacific R. R. The Central Branch was begun at Atchison, 20 miles down the river. The original project at St. Joseph was revived in 1866, and about 1871 eventuated in the St. Joseph & Denver City R. R., built as far as Hastings, Neb., and is now part of the U. P R. R. system.

As to the theory of erosion of the right banks of rivers: The Missouri river touches the left hand bluff at Sargent's Bluff, above Sioux City, Ia., and not again until reaching Dallas Landing, 14 miles by land above St. Joseph, Mo., again at Amazonia and St. Joseph and at three or four points before reaching Kansas City. It hugs the right bluff in two and three mile stretches, and has fully 90 per cent. of its bottom lands on the left bank, with an obvious tendency in the 33 years I have known it, towards the right bank. The Mississippi river also exhibits a strong tendency to the right bank between Keokuk and Cairo, but the reverse farther down. These peculiarities may be fully or mainly accounted for by the geologist, however. "One swallow" or two even, do not "make a summer."

L. W. DENSMORE.

Structural Iron and Steel.

19 *Great George St., Westminster, S. W.*
LONDON, Jan. 11, 1888.

EDITOR ENGINEERING NEWS:

In your last issue of Dec. 24, I note the addition to Mr. HOLBROOK'S letter inviting me to send further details as to my tests upon the effect of cold on Iron and Steel. You are quite right in supposing that I would willingly do so, on seeing the interesting discussion in your journal, following upon Mr. RAMSEY'S paper. From the first moment of reading it I intended to offer some remarks, but have delayed the same. Seeing that this discussion is continued, I will not delay any longer, but willingly offer what I have to say on the subject, which has been a favorite study of mine these 5 and 20 years.

I deeply regret not knowing the author, as communications between us before the experiments were made, might have led to more clearness in the solution of this important problem. I must now beg through your kind medium to have the papers sent herewith communicated to him, in the hope that he will make such extracts as he considers of interest.*

Like the author, I regret to be in the minority amongst the authorities on this subject, but I am by no means inclined to give up my position, inasmuch as it has gained ground these 5 and 20 years amongst all practical men. The fact of the matter is this: When technical problems turn up in consequence of new structures, such as railway plant, and new materials, such as steel, the theorists, having from olden time the upper hand, continue their experiments in the old fashion, and apply their conclusions both to the new material and to the new purpose for which it was to be used. These are then apt to be misleading, and the practical man steps in to say that, notwithstanding your theoretical doctrines, practice proves the reverse; and then the two sides of the question are in conflict.

I fully agree with you that there is nothing that deceives more than experiments and hasty conclusions drawn from them. I have no hesitation in saying that half the experiments and the published conclusions founded upon them are misleading—not always so intentionally, but in consequence of a desire to get at the truth in a comfortable way by using modes of testing which do not apply to the case, when of course the conclusion will be misleading.

I do not speak of such experimentalists as those representing trade interests and patents, nor do I speak of those having for their motive a desire to make a name by throwing out novel doctrines, and who make their experiments to suit their pre-conceived conclusions—for there are many of them as blind as fanatics. But take disinterested, deeply theoretical and scientific experimentalists. It is against such even that practice has to protest; and very often it is hard to explain where lies the mistake.

Considering the great number of different conditions and the variation in material, both in composition and in mode of working, making the material irregular, how could it be otherwise than that results leading astray will appear in nine experiments out of ten? Thus true advancement in the knowledge of the facts is progressing very slowly. Take this instance—the effect of cold upon railway plant generally. Authorities, such as STYFFE, WHOELEL and FAIRBAIRN, say that cold has no weakening effect. Practice on thousands of miles in different countries, however, shows that it has an enormous effect. There is therefore no wonder that theory should be required to be at least balanced by practice; and I am glad to say that practice will gradually take the lead over theory.

The reasons why I believe that in this instance the theorists have reached a wrong conclusion are, first, because they have not tried the articles in the way that they are tested in practice, in daily work; secondly, because the difference in material both in composition and in working is so irregular that the already numerous experiments have not been sufficient to ascertain all the conditions existing in practice. They stick to their tensile test, and draw thence conclusions for such articles as are subjected to concussion or impact.

The basis on which I stand has been, to test articles as nearly as possible in the same manner as they are tested in actual daily practice in the functions they have to execute. On my first communication to the Civil Engineers in 1868, when I advocated the falling test for rails, makers opposed me; and ZERAH COLBURN, then editor of *Engineering*, gave a smart account of the discussion as follows: "Never was there a more brotherly love between makers and engineers. The former said to the latter 'Dear Brethren, leave it to us who understand it better, the rule of testing a rail with a ball is really not quite the right thing, because the rail might break—and the following test was actually to be given up for the tensile and lever test, which has really nothing to do with it." However, I am glad to say the principal of the falling test has been maintained and in practice has really gained ground these 5 and 20 years, so that material and structures which are exposed in daily practice to concussion are now more and more being tested by concussion. I fully admit the difficulties in doing it, and even the rudeness of such tests; but where should I have been—having on an average to inspect per year 100,000 tons of steel, mostly exposed to impact—if I had not stuck to the falling test?

If the proof of the pudding is in the eating, I have no reason to complain. See my article on Swedish Railways in the *Engineer* on Dec. 13. To have had 6,000 miles of railways and 30 years experience in a country where mercury freezes every winter, and not a single accident from broken rails or railway plant, means something that no other country can show, and makes me most cautious in changing my system. Had I admitted such steel into my rails for Sweden, as that which is now in vogue in America, with a view of getting the maximum of wear, I believe I would have had to sacrifice safety. For instance, rails containing carbon .48 silicon .10 phosphorus .102 manganese 1.18. It does not follow that such rails will absolutely break in the States where the climate is milder; but I think it is drawing it very fine, and that there should be a fixed limit for hardness regulated by considerations of safety, for such an increased hardness can only be combined with safety by giving increased weight.

As for the effect of cold, the hardness, particularly if it is got by phosphorus, increases the danger many times, for the old term of "cold short" applies to steel just as well as iron, particularly if the hardness is got by phosphorus and not by carbon. With steel with a minimum of phosphorus, say, half as much as stated above, the different resistance between summer and winter might be next to nothing; while a structure with such a chemical composition as above, or with more phosphorus, would be most materially affected during winter. The difference would be even greater in the form of a bridge than in the form of rails, because of the material being so cut up, and everybody knows that the greatest strength of the steel lies in its skin, particularly if it is hard. Thus, while I am a great advocate for steel in all articles that are subject to wear by abrasion, because of its homogeneity, and in all structures where the maximum of strength, together with lightness of construction, is the main point, still precaution is absolutely needed, not to go too far in hardness and let economy get the upper hand of safety. I remain, dear sir,

Yours faithfully, C. P. SANDBERG.

*The following is a list of papers on the subject of the effect of cold which I herewith beg to forward:—

1. One leaf out of a report to the Swedish Government Railways on the effect of cold upon "Railway Material in Russia" after a visit there 20 years ago.
2. "Strength of Iron and Steel" by STYFFE, published in 1869, but out of print, so I can only send a translation of the same into German by BARON WEBER.
3. An article on "Broken Rails" extracted from *Engineering* in 1872.
4. Part of the Discussion in the Am. Inst. Mining Engrs. in 1882 on "Iron and Steel considered as Structural Material."
5. "The Effect of Temperature on the Strength of Railway Axles" communicated to the Institution of Civil Engineers in 1886 by THOMAS ANDREWS'

Thacher's Computing Instrument.

EDITOR ENGINEERING NEWS:

Can you inform me, in the columns of your paper, how, and for what cost I may obtain the "Computing Instrument" devised by Mr. EDWIN THACHER, also something as to its scope as compared with the slide rule? Is the use of the instrument very intricate or beyond the ability of a clerk of average ability without a technical education?

[The instrument can be obtained from this journal or from the manufacturers, Messrs. KEUFFEL & ESSER, for $30. It is the precise equivalent of a slide rule 60 or 80 ft. long, we forget which, reading accurately to something less than $\frac{1}{100,000}$ part, according to eyesight. It, of course, is not so handy to use as a slide rule 1 ft. long, which enables one to read to $\frac{1}{1000}$ part, or less (often quite close enough). But anyone who can use the one can use the other with a little practice, and anyone who can lay off distances accurately by scale, as any good engineer's clerk should be able to, can use either. The average "clerk" we should not like to trust.—ED. ENG. NEWS.]

PERSONAL.

Major D. B. BRIDGFORD, contractor, died in this city Feb. 21.

ALEXANDER H. BAUER has been appointed Chief Electrician for the Pullman Palace Car Co.

CARROLL PH. BASSETT, of Newark, N. J., has been engaged to prepare plans for and report on water supply and sewerage systems for Watkins, N. Y.

HENRY FLEMING, formerly Superintendent of the Missouri Pacific lines in Texas, has been appointed General Superintendent of the St. Louis, Arkansas & Texas Ry.

S. B. MCCONNICO of the Honduras North Coast Railroad & Improvement Co., has gone to Honduras in the interest of the company.

ANDREW J. STEVENS, General Master Mechanic of the Southern Pacific R. R., died at Sacramento, Cal., Feb. 11. He was first with the Chicago, Burlington & Quincy R.R., but had been with the Southern Pacific since 1870.

WILLIAM THORNBURGH, formerly Superintendent of the Cleveland, Lorain & Wheeling Ry., has been appointed General Manager of the Ohio Valley Ry., with headquarters at Cleveland, O. He succeeds ISAAC REYNOLDS, resigned.

J. M. JOHNSON has been made Chief Engineer of the Louisville Bridge & Iron Co. at Louisville, Ky., filling the vacancy created by the death of Mr GILMAN TRAFTON, which occurred about a year ago Mr. JOHNSON had served as assistant to Mr. TRAFTON.

R. MONTFORT has been made Chief Engineer of the Louisville & Nashville Railroad Co. The company has not had a chief engineer since Mr. DEFUNIAK resigned five years ago, since which time Mr. MONTFORD has been resident engineer and the late Mr. F. W. VAUGHN, consulting engineer.

WM. H. MORROW, of Philadelphia, a Member

of the Baldwin Locomotive Works firm, died at his residence in that city on Monday, Feb. 20. Mr. MORROW had been connected with the works for more than 20 years.

DEXTER BRACKETT, who has been connected with the city engineer's department of Boston, for the past 19 years, has been appointed Superintendent of the Eastern and Mystic divisions of the Boston waterworks. E. R. JONES, who has been with the Eastern division for 34 years as Assistant Superintendent and Superintendent, has resigned on account of age and failing health. J. H. BROWN, who has been Superintendent of the Mystic department, has been placed in charge of the Mystic valley sewer.

JOHN W. HILL, a Consulting Engineer of Cincinnati, O., has just won his suit in the courts of that city for the recovery of $279.57 due as a salary for services as consulting engineer in connection with the new pumping engine. The city had entered a counterclaim for $3,000 received by Mr. HILL as royalty on a patent condenser (owned by him) which formed a part of the accepted engine. The city solicitor claimed that HILL was an officer of the City Government at the time and could not be legally interested in a contract with the city. But the Court has ruled that HILL did not fill an office under the City Government in a legal sense, but was giving his services to the City upon a special contract, and, therefore, the law did not apply in his case, and the claim for salary stands good.

GEORGE H. CORLISS, famous as an engine builder and mechanical engineer, died at Providence, R. I., on Feb. 21. Mr. CORLISS was born in Easton, N. Y. and when he was 25 years old first saw the interior of a machine shop. In 1844, he went to Providence, and in 1846 commenced his development of the steam engine; in 1848 he completed an engine which embodied the essential feature of the engine now known over the world by his name. He took the highest prize at the Paris Exhibition of 1867; received the Rumford medal in 1870, and the grand diploma at the Vienna Exhibition of 1873. Mr. CORLISS was a Commissioner to the Centennial Exhibition of 1876, and his engine there added to his fame, and cost him, individually $100,000. In late years he also built several very effective though original pumping engines.

Reports of State Railroad Commissions.

The report of the Maine Railroad Commissions for the year 1887 will soon be issued. There are at present 1,182.22 miles of railroad in the State. The most important piece of work in progress in the State is the construction of the International (Canadian Pacific) from the International line east to Mattawamkeag. The work has been slow on account of the rough and difficult country and trouble in obtaining laborers, but it will probably be completed during the present year. The York Harbor & Beach road has been built and put in operation during the past year. It is 11.2 miles in length. The report gives an account of the condition of each road in the State and of the betterments completed, under way, or to be recommended upon each. The accident record for the year was as follows:

	Killed.	Injured.
Passengers	1	8
Employés	12	23
Others	14	5

The net income of the roads given below was as follows;

Aroostook River	$ 13,279.72
Atlantic & St. Lawrence	257,394.86
Bangor & Piscataquis	87,012.30
Bangor & Katahdin Iron Works	1,498.89
Boston & Maine	2,901,052.70
Bridgton & Saco River	5,922.29
Eastern Maine	9,000.00
European & North American	125,042.00
Kennebunk & Kennebunkport	2,925.00
Knox & Lincoln	48,001.51
Maine Central	1,202,797.37
Monson	149.53
Orchard Beach	2,527.92
Portland & Ogdensburg	81,104.30
Portland & Rochester	44,611.85
Portland, Saco & Portsmouth	99,254.39
Portsmouth, Gt. Falls & Conway	15,071.97
Rumford Falls & Buckfield	17,389.09
St. Croix & Penobscot	15,060.16
York Harbor & Beach	3,115.99
Portland Horse	2,821.07

Messrs A. W. WILDES and D. N. MORTLAND are the Commissioners.

The annual report of the Minnesota State Railroad Commission has been given to the press. The amount of the taxes paid into the State Treasury for the year ending Dec. 31, 1886, was $372,236.48, an increase of $30,492.93 over the previous year.

The number of passengers killed was 7, and the number of injured 32; number of employés killed, 45; number injured, 46; total casualties, 496. Total number of employés on all the lines June 30, 1887, was 61,489, an increase of 1,138 over 1886.

The total number of passengers carried during the year was 8,141,163, against 6,323,188 in 1886. The average rate per mile was 2.48 cts. in 1887 and 2.70 cts. in 1886. The total number of tons of freight carried in 1887 was 11,156,382, against 9,178,668 for the previous year, and the average earning on each ton was was $1.64 in 1887 and $2.01 in 1886. The average rate per ton per mile in 1887 was 1.27 cts.

The Commissioners quote the State law providing that all charges for transporting freight and passengers shall be equal and reasonable, and they call attention to the fact that this law is practically nullified by the clause providing that, "nothing in the provisions of this act shall be construed to prevent common carriers from issuing passes for the free transportation of passengers."

The report relates the opposition shown by the companies to all interference with and attempts to control their affairs by State authority, as shown by their appeals to the courts. While the amount at stake in the several cases now pending in the courts is small, the principle involved is the power of the State to fix rates and otherwise regulate the business of transportation and its proper decision is a most important matter.

The report gives the total of stocks and bonds of all the railroads in the State, as reported June 30, 1887, as $190,223,032. The average cost per mile of all the railroads in the State was $39,048.

Rapid Transit Hearings in Boston.

At a Legislative committee hearing of the Massachusetts Legislature, Feb. 1, statements of some interest as bearing upon the rapid transit question were made by Col. THOMAS W. CLARKE, Counsel for the Meigs Elevated Railway Co., in regard to the history of the endeavors that have been made to obtain improved transit facilities and the present status of Massachusetts law relating to elevated railroads. He first outlined the first introduction of elevated lines in New York some twelve or fifteen years ago and the effects of passenger elevators in buildings to concentrate business in a small area. Applications for elevated railways in Boston have been made in the Massachusetts Legislature since 1878. For three years no plan appeared showing well approved engineering features. In 1880 the Meigs design, although incompletely worked out, was first brought before the Legislature. No other solution or plan embodying good engineering features was at that time to be had. In each succeeding year the Meigs people have asked for the right to build their system, and in 1884 a bill first passed the House and Senate. The law is such that no street or steam railway can be built in the State of other gauge than 4 ft., 8½ ins., except the narrow gauge of 3 ft. for a steam railway. The gauge of the Meigs railway is 22½ ins. so that a special charter was granted permitting this road to be built but containing also many restrictive limitations. One of these provisions was that the Board of Railroad Commissioners or some competent engineer to be appointed by them should make a careful examination of the structure and report both upon the structure and motive power as to its safety and security before a passenger could be carried. An experimental section of track and an engine, tender and passenger car were built of full size. In these demonstrations $117,000 in cash were expended. Gen. STARK was selected by the Railroad Commissioners as the engineer to make the examination, and after several months study of the system and severe tests of the strength and safety of every detail, made a report approving the construction as a safe method for passenger transportation. This report was approved by the Railroad Commissioners, which thus settled the engineering questions involved.

The next step under the charter obtained was to petition the city of Cambridge to fix a route, one mile long, which was done last July. The law makes the charter void if construction is not begun within one year of the time of filing the route. Again, the position of the Meigs people was so anomalous that, coming as their charter did, partly under the provisions of the general law relating to steam railways and partly under that relating to street railways, they were obliged to make two petitions, one to fix a route as in the case of a steam railway and another to obtain a location of track in the streets, as is required of the horse railway companies; something which no other railway was ever required to do. The location was given in August.

By another provision of the charter, $100,000 of capital per mile was obliged to be put up and the entire sum required to be paid into the Treasury before beginning construction, and it was required furthermore that the Railroad Commissioners should also be satisfied that this money would be sufficient to satisfy all damages. As it was estimated that 10 miles of track or 5 miles of double track, were absolutely necessary in order to pay the smallest dividend on the investment, this required the paying in of $1,000,000, besides another million for stations, equipments, supplies and damages, making $2,000,000 before a post could be legally put in the street. The result of this provision of the charter is that it is impossible to estimate the amount of damages in advance of construction, and the damages are left indeterminate, to be settled within one year of the building of the road, either by agreement or by suit brought. The contingent liabilities are so large and uncertain under this law as to discourage any one from building under it. They now ask that this law be so amended as to allow a knowledge of what the damages are to be and the settlement of damages in advance of construction, as in right of way obtained in the case of ordinary steam railroads by eminent domain.

This legislation contrasts strongly with the extremely liberal New York Rapid Transit Act, under which the New York elevated railways were built. The attempt was then made to cut off all payment of damages by a section affirming that the use of the streets for such purposes was not a new servitude upon them. By suits and decisions the law now is that notwithstanding this statement such use is a new servitude, and hence that damages are to be paid when streets are taken for these purposes. As an illustration of how the present Massachusetts law works, it was stated that a fair valuation by a canvass of the asking prices was obtained in Cambridge of the land adjacent to the proposed line, some months in advance of a knowledge by the land owners of the proposed location. A similar canvass after the route was fixed showed that those same parties held this land at just about twice the former prices, and when asked if the increase of value would not compensate them for the damages, these parties asked a sum for damages equal to one-half the present value of their land, or to the entire original assessed value.

A good deal of the difficulty which the Meigs system has in getting started is due, unquestionably, to doubts as to its mechanical details. There can be no doubt that the system as it now is, has certain crudities and imperfections in it which demand correction, and which the inventor is too enthusiastic, and perhaps opinionated, to correct himself but the system has certain features of decided merit, especially for a city like Boston, which has many narrow and crooked streets. We propose to give a fuller description of the system shortly, and in the meantime reserve further comment on it.

SOCIETY PROCEEDINGS.

Engineers' Club of St. Louis.—The club met Feb. 15 at Washington University, President HOLMAN in the chair, 30 members and 4 visitors present. EDW. H. CONNOR, E. C. PARKER and BATHURST SMITH were elected members. On motion, the report of the special committee on the Waddell Pamphlet on highway bridges was taken from the table. After a very general discussion and the proposal of a number of substitutes, none of which met with the club's approval, the matter was made the special order of the day for the next meeting. The secretary reported having sent copies of the resolutions adopted at the last meeting on the subject of self-registering rain gauges, to members of Congress interested. He also announced that he had received, for the club, a copy of 1883-87 report of the aqueduct commissioners of New York on the new Croton aqueduct. Mr. O. L. PETITDIDIER presented a paper on "Practical Notes on Masonry and Stone Laying." He called attention to the great antiquity of the subject and its interest to engineers. He mentioned many points of value in such construction, and necessary precautions to be taken. The quality of the stone was of prime importance, and he read the government specifications on the subject. Among other points touched upon were mortar, cements, sand, pointing, expansion, laying masonry, transportation and plant.

W. H. BRYAN, Secretary.

Engineers' Club of Kansas City.—A regular meeting was held Feb. 6; 14 members and 8 visitors present. J. A. L. WADDELL was elected Treasurer, and H. A. LASLEY, A. W. BOEKE and F. L. MILLS, Members.

The paper of the evening on the "Inspection of Iron Bridges and Viaducts," by B. L. MARSTELLER, was read and discussed.

The Committee appointed to consider Mr. WADDELL's pamphlet on "Highway Bridges" presented their report, and it was proposed to devote the regular meeting of April to a discussion of the pamphlet, in which discussion several eminent bridge engineers and builders should be invited to take part.

KENNETH ALLEN, *Secretary.*

Ohio Tile, Brick & Drainage Association.—The annual meeting was held at Columbus, O., Feb. 14. Papers were read as follows: "The Best Methods of Preparing and Handling Clays for Brick and Tile," J. G. WAGNER, of Covington; "Tile Drainage," J. J. W. BILLINGSLY, of Indianapolis; "Cracked Tile and Its Causes," W. S. POSTLE, of Camp Chase. The various committees submitted their reports. President, W. A. ENDALY; Vice-President, J. E. FARNHAM, of Richland; Secretary, D. C. POSTLE, of Galloway; Treasurer, S. E HAGGY, of Etna.

A CORRESPONDENT calls our attention to the fact that there are now four parallel roads between St. Joseph, Mo., and Atchison, Kan. The Kansas City, St. Joseph & Council Bluffs, the Hannibal & St Joseph, the Chicago, Rock Island & Pacific, and the recently completed St. Joseph & Santa Fè R. R., a part of the Atchison system.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 125).

Green River, Wyo.—The works were built about 1875 and are owned by the Union Pacific Railway Co. The supply is by direct pumping from Green river. There are 2 No. 9 Knowles pumps with a daily capacity of 150,000 galls.; 2 miles of 4-in. cast-iron pipe, 30 taps and 10 hydrants; also a railway tank 15 ft. by 20 ft. The ordinary pressure is 25 lbs, fire pressure 80 lbs. The annual expenses are not kept separate from other railway work. The Superintendent is E. A. LINSLEY, foreman of the round house, U. P. Ry. The present population is about 500.

Rock Springs, Wyo.—The works were commenced in Oct., 1886, and will be completed by Feb. 29, 1888; they were designed by V. G. BOGUE, R. E. BRIGGS and E. C. KINNEY, for the Union Pacific Railway Co.; E. C. KINNEY, of Green River, was Constructing Engineer, and is now Superintendent. The works are owned by the railway company and cost about $200,000; no stock or bonds were issued. The villages do not pay the company yet for the water supply. The contractors for masonry, foundations, buildings, trenching, pipe laying, valves and hydrants, are L. Strang & Co., Omaha, Neb. There are 2 Knowles duplex pumps with 4 plungers, each 7×18 ins.; daily capacity 500.000 galls; also 2 boilers of 100 H. P. each by J. Mohr & Co., Chicago. The company has built a reservoir with a capacity of 3,000,000 galls. Ludlow valves and Chapman hydrants are used. The are 22 miles of cast-iron pipe, 150 taps, 150 meters and 47 hydrants. There are 17 miles of distribution and 5 miles of main pipe; most of the distribution pipe is 8 ins., the balance 4 ins. The service pipe is wrought-iron galvanized. The supply is drawn from Green river and pumped to the reservoir. Average daily consumption, 300,000 galls. Ordinary and fire pressure, 66 lbs. The works cost $200,000, and the annual expense is about $20,000. The present population is 2,500.

UNION PACIFIC RAILWAY CO.
GREEN RIVER, WYO., Feb. 10, 1888.

EDITOR ENGINEERING NEWS:

I may add a little explanation of the accompanying reports. Green River village is on the Green river where the Union Pacific Railway crosses. It is a division station on the railway and has no business except as brought by the railway shops. The water supply system was built by the railway company for shop use and later a 4-in. main was laid to some parts of the town. There is a small revenue from the few who use it, but it is not enough to be called a water-works system.

Rock Springs is a large coal mining camp, located 16 miles east, and up Bitter creek from Green river. The country is so full of alkali that the water cannot be used for cooking or for steam. Formerly the whole water supply has been by a train of 12 cars, making from 1 trip a week in early days to trips a day lately, from Green River. The building of a water system has been under discussion for the last 10 years but only in Oct., 1886, was a contract let and work begun.

The new pumping works are located on the banks of Green river, near the old plant. We have made a connection between the new and old systems with a 4-in. cast-iron pipe and a pressure reduction valve for an emergency, but generally the two systems will be run separately.

The new house is a fine building of Colorado sandstone and iron roof, with a 70 ft. chimney, 40 ins. square inside. Inside are 2 fine steel boilers, 5 by 20 ft., with 4 in. flues, built by J. Mohr & Son, Chicago. In the pump room are 2 Knowles duplex pumps, 16 ins. by 18 ins. steam end, 7 ins. by 18 ins. water end; also a No. 3 Knowles for boiler feed. The main is 8-in. cast-iron all the way. The line starts with 1,000 ft. of 67 lb. pipe, then 3 miles of 50 lb. pipe, 1 mile of 67 lb. pipe, 8 miles of 50 lb. pipe and the balance 43 lb. pipe. The first plan was to put in an intermediate pumping station, and with that in view the light pipe was put in at the lower end. It is now the intention to relay the 3 miles of 50 lb. pipe with 67 lb. That will take it to a higher level, where the lighter pipe is ample for the pressure. This may not be done for several years, till the large demand for water will cause heavy friction head; at present the pipe holds very well.

Within a mile of Rock Springs a Y branch turns out and a line is run ¾ mile up into the hills to a reservoir that is built by making an earth dam across the head of a ravine. In the main, just below the Y branch, is a check valve. The line to the reservoir and to the town are both open, so that if more water comes through the main than is used in town, the surplus goes to the reservoir, or if there is not enough coming from the pumps the balance comes back from the reservoir through the same pipe and keeps the pressure constant. It also keeps nearly a constant pressure on the pumps. The most of the water goes to 4 large coal mines that run very heavy machinery, and to a water column for locomotives. The house service is comparatively small. The coal companies own a large part of the houses, and the town is not incorporated, so at present there is no revenue from hydrants, though it is likely some arrangement will be made after a time. We are getting ready to put meters on all taps except the water column, and to base the income charges on actual delivery of water. The charges to the mines and locomotives will be arbitrary, and enough to produce the desired income for the cost of the works. You cannot figure on these works as ordinary city works.

E. C. KINNEY, Mem. Am. Soc. C. E.
Engineer and Superintendent R. S. Pipe Line.

CONSTRUCTION NEWS.

Water.

Sault Ste. Marie, Mich.—The Edison Sault Light & Power Co. has its water power canal and light station completed. The object of the company is to furnish electric light and power. About 1,600 incandescent lamps have already been ordered by the residents and business men of the city. The canal is about ¼ mile long, and has a head of 9 ft. at the wheel house, which is built for 12 turbines. Hodge & Miner, of New York, are the contractors and I. W. MOFFATT, of Montreal, the engineer in charge.

Hamilton, Ontario, is having a local spat over the new pumping engine for the water-works of that town. At the letting of these engines the HOLLY Co., of Lockport, N. Y., was the lowest bidder, but a local builder succeeded in getting his engine accepted at a higher price. The friends of this builder point to a duty test of 114,758,000 ft. lbs., and charge the Hamilton *Times* with seeking to injure "home industries." The *Times* retorts that a HOLLY engine of the same capacity had recently shown an average duty of 119,868 991 ft. lbs. with poorer coal and that its opposition was purely from a business standpoint.

Galveston Water-Works.—LOUIS SIEGEL, 58 Doy St., N. Y., has been awarded the contract for sinking 10 artesian wells of not less than 850 ft. depth. Work to commence within 30 days from the 20th inst. The contract will amount to $80,000, and is probably the largest contract for this class of work, for water, ever awarded.

Greensburg, Kan.—

EDITOR ENGINEERING NEWS: The following may be of interest. Our well, now completed, is 30 ft. diameter and 96 ft deep. All through this portion of the country there is an underground flow of water varying in depth with the undulation of the underlying clay, but usually 10 ft. deep, and the supply is adequate. We put in 2 compound duplex pumps, 10-in. high pressure cylinders, 16 in. low pressure cylinders, 8½-in. water cylinders; 12-in. stroke. These are placed 80 ft. down in the well and upon rolled iron beams resting upon buttresses built out in the walls of the well. We hope to be in running order in a few weeks. It being so deep to water, every indication seems favorable to the franchise being a valuable one.

D. H. RHODES, Secy. and Man.
Greensburg Water Supply & Hydraulic Power Co.

[Information as to the Greensburg water-works was given in our last volume; Nov. 12, p. 354.—ED.]

Electric Light and Gas.—***Dedham, Mass.***—It is proposed to substitute the electric light for the present gas and oil lamps in the streets.

Chestertown, Md.—The Chestertown Water Co. proposes to put in an electric light plant.

Catonsville, Md.—J. M. Cone, of Baltimore, will put in gas works or electric light plant at Catonsville and Ellicott City.

Hagerstown, Md.—A local electric light company is to be organized. An incandescent plant will be purchased from the Edison Electric Light Co.

Wellston, O.—The Wellston Gas Works Co. will build its works in the spring.

Sandusky, O.—An electric light plant will be put in without delay. T. M. SLOANE is General Manager.

Raleigh, N. C.—The streets are to be lighted by electricity.

Oxford, N. C.—A Thomson-Houston electric light plant is to be put in by N. R. Ruffin and C. A. Ballon, of Danville, Va. They will also put in a similar plant at Henderson, N. C.

Troy, Ala.—A local electric light company is proposed.

Shreveport, La.—The contract for lighting the streets by electricity for 3 years has been awarded to the local company.

Bay City, Mich.—Franchises have been granted to the West Bay City Electric Light Co. and the Edison Light & Power Co.

Anna, Ill.—The new electric light plant has been put in and the system is ready for use.

Chicago, Ill.—Prof. BARRETT proposes to unite the city and county electric light plants.

Yankton, Dak.—A 40 H. P. electric light plant will be put in; there will be 500 incandescent and 25 arc lights.

Ogden, Utah.—Work is progressing on the new gas works.

Santa Fè, N. M.—It is proposed to organize an electric light company.

Tucson, Ariz.—Money is being subscribed for an electric light plant. Address A. Bagnall.

Buena Vista, Cal.—The University Electric Light Co. has contracted with the Heisler Electric Light Co., of St. Louis, Mo., for a plant of 300-candle power.

Houston, Tex.—The Jenney Electric Light Co., of Fort Wayne, Ind., will put in a plant for the city.

Marshall, Tex.—C. A. Murray has organized a syndicate to put electric light plants in several cities. Work is in progress at Marshall and Greenville.

Water-Works.—***Maine.***

FORT FAIRFIELD, Feb. 10.

EDITOR ENGINEERING NEWS: Our village contains about 3,000 inhabitants with a probable money value of property of $200,000. We have a village corporation secured at the last Legislature, as well as the charter for water company. We have made no definite arrangement as yet for building works but propose to have them built next summer. The source of supply will be by gravity from a good brook 2 miles from the middle of the village and the proposed reservoir will be 150 ft. above the village street. The present supply is from the river and wells. The works will probably be built by the Sarsfield Water Co.; President, JOHN B. TRAFTON, and contracts will be let in the spring. The probable cost is estimated at $20,000. Hydrant pressure will be used for fire purposes. Nothing of a financial character has been determined upon yet in regard to the works.

N. H. MARTIN,
Chairman and Clerk of Village Corporation.

New Hampshire.—Wolfboro. Water-works are to be established. Address the City Clerk.

Massachusetts.—Mansfield. A new bill for a charter for a water supply is before the Legislature, as the act passed a year ago is said to be insufficient.—Maynard. Water-works are proposed.

New York.—Herkimer. Proposals for the water-works were opened last week, 48 bids were received. The works will probably be put under the control of a board of water commissioners.—Lansingburg. The town has voted this week on the issue of $25,000 water bonds.—Greenport. A proposition to put in water-works for domestic and fire purposes has been made by Lovell and Swain, of Brooklyn. Messrs. WELLS, MILES, PRICE, DAVIS and REEVES are a committee in charge of the matter.

CUBA, N. Y. Feb. 11.

EDITOR ENGINEERING NEWS: Our village is now warm over the subject. Sentiment is about even for and against the corporation assuming the construction of the works, but is gradually growing in favor. The present supply is by wells in the village for hand fire engine. The proposed supply is at the head of a stream 2 miles distant, run by gravity; elevation 170 ft.; the hydrant pressure will be used for fire purposes. A vote will soon be taken by the tax payers and if carried bonds will be issued. Probable cost, $30,000 to $40,000. Population, 1,500. J. N. SHELDON.

New Jersey.—Toms River. The shares of the new water company have been taken and work will be started in the spring. The stand-pipe will be on an elevation between that town and Island Heights and will be 120 ft. high. There will be 7 miles of pipe. Direct pumping can be applied when necessary. Water will

also be supplied to Island Heights.——Newark. The Common Council has authorized the expenditure by the Aqueduct Board of $450.000 for a new reservoir and other works.——Keyport. Mr. LUFBURROW has introduced an Assembly bill to give the city power to contract for a water supply.

Pennsylvania.—Reading. The Board of Health has returned the proposition for a supply from Maiden creek, and recommends a supply from the Schuylkill.

Ohio.—Painesville. Water-works are projected.——Washington C. H. Samples of water are being obtained by J. P. Martin for analysis.——Fostoria. The new franchise between the city and Ferris & Halladay provides for the payment by the city of $60 per hydrant up to 100 and $50 each for all beyond that number.——West Cleveland. A bill has been introduced authorizing the village to issue bonds for $12,000 to redeem outstanding water bonds and to provide for extensions of the works.

Georgia.—Rome. J. H. Reynolds and G. W. F. Lamkin propose to build water-works at East Rome.——

DALTON, Ga., Feb. 9.

EDITOR ENGINEERING NEWS: It is proposed the city shall build water-works, the supply to be obtained from a large spring and pumped to stand-pipe; hydrant pressure to be used for fire purposes. The probable cost is $25,000 to $30,000, for which bonds are to be issued. Work will be commenced at an early date and completed by the end of the year. Population 3,500. We propose to let some reliable company put in the plant and the city pay a liberal price for the water, provided we fail to sell our bonds. The bonds run for 30 years at 5% interest, payable semi-annually; every dollar of the entire city is bond for the payment of the bonds. Dr. J. R. MCAFEE.

Kentucky.—Harrodsburg. A bill is before the State Legislature to incorporate the Harrodsburg Water Co.

North Carolina.—Oxford. Water-works are to be built. Address ROBERT W. WINSTON.

TARBORO, N. C., Feb. 14.

EDITOR ENGINEERING NEWS: The present supply is obtained from wells, creek and river. We have no water works. The matter has been considered and talked about, but nothing done as yet. Our citizens are all favorable, but have not devised plans or taken any steps in the matter. The field is open to any enterprising company which may wish to enter it. The town, population 3,000, very much needs water-works. For further particulars address S. S. Nash and Geo. Howard. W. E. FOUNTAIN.

South Carolina.—Columbia. A site for the new reservoir has been decided upon by the city council.

Alabama.—Eufaula. The water-works were completed Feb. 15.——Autaugaville. The water-works are nearly completed. The supply is obtained from a spring a mile distant. The works were built by Smith and Muir.

Florida.—Fernandina. Proposals for the construction of water-works will be advertised shortly. Address the mayor.

Michigan.—Howell. A vote on the issue of $25,000 for water-works will be taken March 5.

Missouri.—Washington. The Water Committee, Messrs. JONES, BERNKE and HAGEBUSCH, will advertise for bids, to be received until April 2. An engineer is to be engaged.——Kansas City. The break in the Quindaro reservoir will be repaired at once.

Arkansas.—Alexander. A company has been organized to put in water-works.

Wisconsin.— WHITEWATER, Feb. 10.

EDITOR ENGINEERING NEWS: There are no water-works here yet, but a supply is proposed from springs or artesian wells. It is desirable to pump to stand-pipe, and hydrant pressure will be used for fire purposes. The works will probably be built by a private company. The cost cannot yet be estimated. Contracts will be let during the coming season; work to be commenced in the summer and completed in the summer of 1889. The population is 5,000, in round numbers. Mayor ENGEBRETSEN can give further information. The Council has authorized the mayor and clerk to engage a competent engineer to come here and investigate the matter, and if feasible to go ahead and make plans and specifications. Nothing further done as yet.
How. S. SALISBURY, *City Clerk.*

Nebraska.—Edgar. Plans and specifications for a water-works plant to cost $20,000 are being prepared by A. A. RICHARDSON, of Lincoln, Neb.——Tecumseh. The town will vote on a $21,000 water-works system. Plans and specifications furnished by A. A. RICHARDSON, of Lincoln.——Holdrege. Work on the new water works will be commenced March 1.

Utah.—Salt Lake City. During 1887, the city extended its water system by 10 miles of pipe and built 3 new reservoirs, at a cost of $90,000.

California.—Los Angeles. The Tiyunga Water Co. has been organized by F. C. GARBUTT and others. Capital stock, $500,000.——Auburn. The water-works were tested recently, with satisfactory results.

Texas.—Waco. The Waco Water Co., has rejected the contract proposed by the city and proposes that the city shall have the company's plant for 5 years at $22,000 per annum.——Laredo. A committee has been appointed to consider the question of putting in water-works.——Decatur. A company has been organized to put in water-works and electric light, also a street railway. Capital stock, $100,000. Address A. EDMONDS.——Greenville. Capt. CHAS. H. LEDLIE, C. E., of St. Louis, Mo., is in the city to prepare plans for the water-works proposed by St. Louis and Greenville parties.

Sewerage.—*Manchester. N. H.*—It is proposed to issue bonds for $200,000 for a sewerage system. Dr. GEO. C. HOITT is Chairman of the Board of Health.

Ware, Mass.—The plans for the sewerage system prepared by Mr. DAVIS, C. E., of Northampton, have been approved by C. A. ALLEN, City Engineer of Worcester. If approved by the sanitary commissioners, the plans will be considered at the town meeting in March.

Greenbush, N. Y.—The engineers have reported to the Sewer Commissioners on the work yet to be done. There are 42,645 ft. to be sewered, which would cost $76,798; this can be reduced to $37,110 ft., costing $60,498. The cost can be reduced to $53,000 by reducing the size of the pipe and the number of catch basins.

Oneida, N. Y.—The report of WALTER F. RANDALL proposes a system of 9 miles of sewers with 3 outlets to Oneida creek. The cost is estimated at about $160,000.

Raleigh, N. C.—Prof. J. L. LUDLOW, Engineer of the sewerage system has made his report to the committee. He states that there is ample surface drainage and that the rain water need not be carried through the sewers. The pipe is recommended to be 8 ins. diameter, street laterals 6 ins. Pipe laid 6 ft. deep. The cost will be about $75,000. Bonds will be issued and proposals are now advertised for.

Montgomery, Ala.—The Finance Committee has been authorized to issue bonds for a system of sewerage. W. S. REESE, Mayor.

Red Jacket, Mich.—A system of sewerage is projected.

Rochester, Minn.—The Council has accepted the proposal of C. F. LOWETH, C. E., of St. Paul, Minn., to prepare plans for a system of sewerage. Work on the sewers will be commenced this summer.

Aberdeen, Dak.—The City Council has accepted the plans of W. WILLIAMS, C. E., of Chicago, for a system of sewerage similar to that in use at Pullman, Ill. The cost is estimated at about $40,000.

Lincoln, Neb.—A report on the proposed storm sewerage has been made to the City Council by O. N. GARDNER, City Engineer, and AUSTIN HUMPHREY, Chairman of the Board of Public Works. It is said that the sewer should be built before the paving of streets to be sewered is laid down. The estimate of cost of the entire system is as follows:

To 470 lin. ft. 5 ft. brick sewer at $6.50	$3,055.00
To 400 lin. ft. 4½ ft. brick sewer at $5.75	2,300.00
To 400 lin. ft. 3¼ ft. brick sewer at $5.00	2,000.00
To 400 lin. ft. 2½ ft. brick sewer at $3.90	1,560.00
To 42 receiving basins at $75.00	3,150.00
To 31 manholes at $75.00	2,325.00
To 1,680 lin. ft. receiving basin connections at 75 cts.	1,260.00
To 3,285 lin. ft. 20-inch sewer pipe, laid at $1.40	4,599.00
To 5,460 lin. ft. 15-inch sewer pipe, laid at 85 cts.	4,641.00
Total	$24,890.00

Lighting Companies.—Edison Electric Light and Power Co., Troy, N. Y. LYNN J. BROWNING, of Albany, and others. Capital stock, $100,000.

Enterprise Illuminating Co., Ellicott City, Md. JOSEPH M. CONE, of Baltimore, and others.

Peoples' Gas Co., Raleigh, N. C. President, JULIUS LEWIS. Capital stock, $30,000.

Shreveport Incandescent Electric Light Co., Shreveport, La. President, B. J. BOURDA; Secretary, B. RIPINSY. Capital stock, $10,000, with power to increase to $20,000. The charter is for 25 years.

Peoples' Electric Light & Water Power Co., Chicago Ill. H. M. PACKHAM, CHAS. W. WAIT, CHAS. P. ANDERSON. Capital stock, $200,000.

Fort Scott Light & Power Co., Fort Scott, Kan. W. H. STOUT, A. W. WALBURN, of Fort Scott, and others. Capital stock, $100,000.

Citizen's Incandescent Electric Light Co., Little Rock, Ark. President, MYER POLLOCK. Capital stock, $50,000.

Phœnix Electric Light Co., Phœnix, Ariz. President, THOS. H. HINE; Secretary, W. A. ROSS.

Contracting.

Artesian Well.—The following proposals have been received by G. H. COLE, City Clerk, Toledo, O.: Frank Hake, Toledo, O., $1 per ft. in earth, $3 per ft. in rock; W. O. Emsberger, Defiance, O., $1.95 per ft. in both materials.

The Lynchburg Iron Co. proposes to add to its plant at Lynchburg, Va., a pipe foundry with a daily capacity of 30 tons.

Dredging.—The Dock Commissioners, New York City, have awarded the contract for dredging at Pier No. 7, East River, to the Union Dredging Co., at 20 cts. per cu. yd. Only one proposal was received.

Pipe and Specials.—The Water Commissioners, Springfield, Mass., have awarded the contract for about 441 tons of cast-iron pipe and 11 tons of specials, to the Warren Foundry & Machine Co., New York. The price is about $15,000.

Street Grades and Sewerage.—Pierson & Kiersted, Consulting Engineers, Kansas City, Mo., will lay out a system of street grades and sewerage at Kansas City, Kan.

Dry Dock.—The new dry dock at the Brooklyn navy yard is to be 600 ft. long, and a bill appropriating $100,000 for the extra 100 ft. has been passed at Washington.

Gas Works.—The contract for the new gas works at Murfreesboro, Tenn., has been awarded to the New York Contract Co. The plant will cost $40,000.

The Birmingham Equipment Co. has been incorporated by GEO. H. NETTLETON and WALLACE PRATT, of Kansas City, Mo.; J. D. CRUISE, Wyandotte, Kan.; C. W. BLAIR, Leavenworth, Kan., and DAVID E. JONES, of Rosedale, Kan. Capital stock, $1,000,000. The company will deal in locomotives, rolling stock and railway equipment.

Pumping Engine.—The Water Commissioners, Mansfield, Mass., have awarded the contract for 2 compound, duplex pumping engines, of 1,000,000 galls. daily capacity each, to the Geo. L. Blake Manufacturing Co., Boston, Mass.

Levees.—The Board of State Engineers, New Orleans, La., has awarded contracts as follows: Caldwell levee, John Caldwell, 12 cts. per cu. yd; Musser levee, W. V. Robson, 14 cts.; Phillips levee, L. B. Phillips, 12¼ cts.; Dorich levee, 15 cts; Landreaux levee, A. S. Gervin, 14 cts.

Electrical Supplies.—The Fire Commissioners, Baltimore, Md., have awarded contracts to Clendenin Bros., for 40 barrels of "blue-stone" at 5¾ cts.; and to the Southern Electric Co. for 2,500 zincs and 1,000 coppers at 30 cts. and 10 cts.

Cable Railway.—William H. Faulkner has the contracts for the 18th and 19th street sections of the cable line of the Metropolitan Railway Co., Kansas City, Mo. Work will be commenced early in March.

Brick and Stone.—At Minneapolis, Minn., the following contracts for material for the new pumping station were awarded Feb. 14: Houston & Harris, 1,018,000 brick at $10.35 per 1000; John Foley, rubble stone at $1 per perch; F. W. Cooke, range rock, footing stone and concrete.

Masonry.—The following were the proposals received by JOHN DONNELLY, City Engineer, Kansas City, Mo., for the piers and abutments of the Fourth St. viaduct: James Murray, $4,320.50; Keefer & Fisher, $4,425.40; Andrew Keating, $5,282.75; M. Walsh, $6,668; E. C. Coolidge, $8,665.91. The contract was awarded to James Murray.

Brick.—The Sewer Committee, Minneapolis, Minn., has received the following proposals: St. Paul & Minneapolis Pressed Brick Co., $10.40 per 1,000; Kelsey Bros., $10.50; C. J. Swanson & Co., $11; John W. Gregg, $11.25; Wisconsin Red Pressed Brick Co., $11.50; W. B. Griswold & Co., $11.60. Contracts were awarded to Kelsey Bros., for 700,000; Swanson & Co., 2,875,000; St. Paul & Minneapolis Pressed Brick Co., 1,000,000. Proposals for 2,000,000 brick will be received June 1.

Gas and Water-Works.—The Consumers' Water & Illuminating Co., Woodberry, Md., has awarded the following contracts: H. R. Worthington, New York City, high pressure pumping engine with daily capacity of 1,500,000 galls, low pressure pumping engine with daily capacity of 1,250,000 galls.; Phœnix Iron Co., Trenton, N. J., blowing engine; Hyatt Filtering Co., Newark, N. J., filters; Bartlett & Hayward, gas holders; Newgent Co., pipe work and fittings; Jos. L. Brooks & Co., Hampden, Md., stone work and laying 82,200 ft. of pipe of different sizes; Connolly & Co., New York, blowers and exhausters.

Gas and Electric Lighting.—The following contracts have been awarded by the Board of Aldermen, Brooklyn, N. Y.: Municipal Electric Light Co., and Citizens' Electric Light Co., $182.50 per light per year; Brooklyn Gas Light Co., $19.80 per lamp per year; Williamsburg Gas Light Co., $21.75; Nassau Gas Light Co., Metropolitan Gas Light Co., Peoples' Gas Light Co., and Citizens' Gas Light Co., $22. The annual appropriation is $500,000, and these contracts will absorb it and leave a deficit.

Galveston, Tex.—Public buildings and works are under way that will cost $1,330,000, as follows: Water-works, contract let, $450,000: city hall, plans accepted and proposals received, $50,000: Sealy hospital, plans accepted, $50,000: public school, $35,000: custom house, in construction, $250,000: bagging factory, in construction, $100,000: ice and cold storage house, commenced, $25,000: life saving station, plans accepted, $10,000; jetty work, amount to be expended, $160,000; permanent street improvement, for which bonds are being issued, with work in immediate prospect, $200,000; total, $1,330,000.

Paving Blocks and Curb Stones.—The following proposals for 60,000 paving blocks and 3,407 lin. ft. of curb stones have been received by the Park Commissioners, Boston, Mass.: GEO. F. CLARKE, Secretary: Paving blocks: Shield & Carroll, $44.37; S. & R. J. Lombard, $48; James J. Vernon, $58. The contract was awarded to Shield & Carroll.——Curb stones: Matthew Paradise Co., $1.50; Albert A. Libby & Co., $1.59; C. J. Hall, $1.65, $1.95; James J. Vernon, $1.69; Rockport Granite Co., $1.69; James A. Colson, $1.70; Cape Ann Granite Co., $1.70; Lanesville Granite Co., $1.79; Shields & Carroll, $1.83; Maine & New Hampshire Granite Co., $1.90; Pigeon Hill Granite Co., $2.59.

The Phosphor-Bronze Smelting Co., Philadelphia Pa., has issued a circular stating that owing to the continued high prices of copper and tin, all prices and discounts heretofore quoted on phosphor-bronze manu-

factured goods are withdrawn. Prices and discounts will be quoted on application and orders received will be filled at reasonable rates. This is a result of the French corner on copper.

Granite Paving and Curbing.—At a meeting of the Board of Contract and Apportionment, Albany, N. Y., held Feb. 20, proposals were received for granite pavement and curbing on Clinton Ave., about 34,000 sq. yds. of granite and 11,000 lin. ft. of curb being needed. Only 2 bids were received, from Jacob Holler, and Anthony N. Brady, both of Albany. As the prices bid were 25 per cent. higher than for any similar work that has been let for several years the bids were rejected and the work was ordered re-advertised. HORACE ANDREWS is City Engineer and Surveyor.

Pile Dike.—The following proposals for constructing a pile dike 1,000 ft. long, in Canarsie Bay, N. Y., were received February 15, by Lt.-Col. G. L. GILLESPIE, U. S. Engineer Office, New York City: Stephen A. Kelly, Brooklyn, N. Y., $9.87 per lin. ft.; John D. Walsh, Brooklyn, N. Y., $11.17: Fearon & Jenks, New York, $11.85; P. Sanford Ross, Jersey City, N. J., $12.35; Thomas Murray, New Brunswick, N. J., $12.38; Chas. H. Edwards, Quincy, Mass., $12.96; Theodore F. Holmes, New York, $13.05; Geo. E. Richardson, Brooklyn, N. Y., $13.45; Henry Du Bois' Sons, New York, $13.90; Moses Engle, Brooklyn, N. Y., $14.50; Francis H. Smith, New York, $15.89; O'Connell & Coffey, Brooklyn, N. Y., $19.75.

Water-Works.—*Murfreesboro, Tenn.*—The contract for water-works for fire protection has been awarded to George E. Downing, of South Pittsburg, Tenn., at $6,560. The system will be direct pressure, and the contract includes pumping engine, boiler and appurtenances, pump house, mains, specials, hydrants, gate valves, hose, hose carts, etc. Work to be commenced within 30 days from date of contract, and to be completed within 90 days of same date. W. B. GARRETT is Chairman of the Fire Committee.

Artesian Wells.—The following were the proposals received February 15, by the Water Commissioners, Galveston, Tex., for artesian wells: J. A. Holloway, of Houston, Tex., bid for a 5-inch pipe, $5.25 per foot; 6 ins., $5.75; 7 ins., $6.25, and 8 ins., $7. For a well the total depth of 2,500 ft., $29,000.

Santiago Murphy, San Antonio, Tex., bid for a 5-inch pipe, $5.75 per foot; 6 ins., $6.25; 8 ins., $7.25. For a well the total depth of 2,500 ft., $33,000.

Goulds & Austin, of Chicago, bid for a well 450 ft. with a 12-inch pipe, $4,750; 800 ft. deep, $9,500. With a 16-inch pipe, 450 ft., $7,750; 800 ft., $10,000. For a well 825 ft. deep with an 8-inch pipe, $7,200.

O. O. Buckelew, of Dallas, Tex., bid on 5 ins., $5.50 per foot; 6 ins., $6 per foot, and 8 ins., $7 per foot.

Daniel Dull, of New York, bid on a 5-inch well, $9.25 per foot; 6 ins., $9.65; 7 ins., $9.85, and 8 ins., $10.25.

Louis Siegel, of New York, bid on a 5-inch well $5 per foot, increasing the price per foot $1 for every inch increase in diameter of pipe, submitting also a supplemental bid guaranteeing to furnish 2,000,000 galls. of water per day for $80,000.

J. W. Byrnes, of Galveston, Tex., bid for an 8 inch well to the depth of 850 ft. (the ascertained depth of the present water source) $7,500 with an 8-inch pipe or $7,000 with a 6-inch pipe. He further offered to guarantee a flow of 10,000 or more galls. per day for $8,000 per well. By this proposition he would receive nothing for wells sunk that did not yield 10,000 galls. per diem, and if he should complete a well that gave an hundred times as much he would get no more than $8,000 for it. He further offered that if the city desired to sink wells to a greater depth than the 850 foot vein he would furnish tools and machinery free of charge, the city paying all bills for material, fuel, water, etc., and to return said tools, machinery, etc., in as good order as when taken.

The above figures are from the Galveston *News*, Feb. 16, which says: "As the Board deferred making public the proposals submitted, the figures as to the various bids were obtained through contractors who were present at the letting, from memoranda taken from the reading of the proposals. The figures are not given beyond the diameter of an 8-in. pipe, as, from experience in well boring in this city, it is hardly probable that water can be reached with a larger size pipe, but more likely a much smaller one."

The contract has been awarded to Louis Siegel, of New York, at his proposal of $80,000. The prices of the former proposals, which were all rejected, were given on page 89.

Proposals Open.

Water Meters.—Lot A, 3,350 ¾-in. and 150 1-in. Tremont meters which have been withdrawn from service; Lot B, 250 ¾-in. and 150 1-in. Tremont meters which have never been in service. Bids per pound or per meter. H. T. ROCKWELL, chairman, Water Board, City Hall, Boston, Mass., Feb. 27.

Street Material.—For the year 1888. Street crossings and Belgian blocks; cobblestones; iron gutter plates; sand. A. E. SMYRE, City Commissioner, Baltimore, Md. Feb. 27.

Fire Hose.—Fabric hose with couplings, 6,000 ft. J. A. PRESTON, President, Fire Commissioners, Baltimore, Md. Feb. 28.

Water Stock.—Additional water stock, $3,000,000. THOS. W. MYERS, Comptroller, New York City. Feb. 28.

Sewer.—Lateral sewers. Plans and specifications at the office of the City Engineer. JAMES BROWN, Comptroller, Allegheny, Pa. March 1.

Street Work.—Grading, Paving and curbing. A. E. SMYRE, City Commissioner, Baltimore, Md. March 2.

Water-works Supplies.—Pipe, branches and sleeves, 4 to 36 ins.; fire plugs and stop gates; ferrules, ¾ to 1 in.; miscellaneous castings; wooden boxes; hauling materials; pig lead; hemp packing; fuel (coal or gas). JAMES BROWN, Comptroller, Allegheny, Pa. March 2.

Water Pipe.—Cast-iron pipe, 3 to 12 ins., and special castings for 1888. Separate proposals for 8,350 ft. of 30-in. cast-iron pipe and specials. JOHN WHITELAW, Superintendent and Engineer of Water-Works, Cleveland, O. March 6.

Jail.—Brick jail, stone foundation, iron or steel cells. B. LE SUEUR, Knoxville, Ga. March 6.

Pier.—Removing old pier and building new wooden pier at foot of North Moore St., North river. The DOCK COMMISSIONERS, Pier A, North river, New York City, March 6.

Sewers.—JOHN P. ADAMS, Commissioner of City Works, Municipal Building, Brooklyn, N. Y. March 6 and 7.

Post Office.—At Prescott, Ont. A. GOBEIL, Secretary, Department of Public Works, Ottawa, Canada. March 8.

County Bonds.—For $40,000 for the court-house, and $20,000 for jail. A. J. GRIGSBY, County Auditor, Circleville, Pickaway county, O. March 14.

Pumping Engine.—Daily capacity, 10,000,000 galls. Two old engines to be sold. H. C. COTTER, Superintendent of Water-Works, Toledo, O. March 15.

Iron Staircases.—For the Departmental Building at Ottawa. A. GOBEIL, Secretary, Department of Public Works, Ottawa, Canada. March 15.

Factory.—At Louisville, for the Kentucky Wagon Mfg. Co. H. WOLTERS, Architect, *Courier Journal* Building, Louisville, Ky. March 15.

Fire Apparatus.—Hook and ladder truck, hose, fire alarm system, battery, etc. A. S. TOOMBS, Chief of Fire Department, Shreveport, La. March 22.

Pumping Machinery.—Five engines with pumps and boilers. GEO. B. SWIFT, Commissioner of Public Works, Chicago, Ill. March 31.

Hotel.—For the Athens Mining & Manufacturing Co., Athens, Tenn. THOS. C. VEALE, Architect, Chattanooga, Tenn. April 1.

Fire Alarm Telegraph.—Complete system. JNO. F. SUMMERSELL, City Clerk, Mobile, Ala. April 1.

Water-Works.—The Water-Works Committee, Washington, Mo. April 2.

Pumping Engine, Inlet and River Work, Engine House and Engine Foundations.—(See advertisement). CHAS. B. LONG, President, Louisville Water Co., 549 Third St., Louisville, Ky. April 2.

Jail.—Plans and specifications on file. JAMES F. BROWN, Louisville, Jefferson county, Ga. April 3.

Bridges and Canals.

Bridge Notes.—*Rhode Island.*—Providence. The commission appointed to apportion the expense of the Seekonk bridge have decided that the $240,474.43 for the bridge and river improvement shall be paid as follows: 66 per cent. by the city of Providence, 19 per cent. by the city of East Providence, 8 per cent. by the city of Pawtucket, and 7 per cent. by the Boston & Providence R. R. Co.

New Jersey.—The New York, Lake Erie & Western R. R. has put in a new steam power draw over the Hackensack river to replace the old hand power draw.——Mauricetown. The Cumberland Co. Freeholders will erect a bridge over the Maurice river at a cost of $50,000.

Pennsylvania.—The Pennsylvania R. R. will this spring put in 90 iron bridges on the Uniontown branch to replace wooden structures.——Philadelphia. The Bridge Committee has prepared an ordinance authorizing the Union Passenger Ry. Co. to build a bridge over the crossing at 9th and Columbia avenue at its own expense. The bridge will cost $85,000.

Maryland.—Frederick. Joseph D. Baker is interested in a project to bridge the Potomac river at Point of Rocks.

Ohio.—Steubenville. A bridge is projected across the Ohio river. The city is asked to vote $40,000 of the estimated cost of $120,000.——Ashtabula. A bridge will be built over the river. It will be 230 ft. long, with a draw. The town will raise $30,000.

West Virginia.—Wheeling. The city of Wheeling and Ohio county have voted to subscribe $100,000 towards the union railroad bridge to be built by the Wheeling & Harrisburg Ry. Co. Surveys are being made.

Kentucky.—Owensboro. The Owensboro & Indiana Bridge Co. is preparing for the construction of the bridge over the Ohio. The work will be done by Capt. W. B. ELLIS, Chief Engineer of the Oakland City, Vincennes & Owensboro R. R.——Carrollton. The Carrollton & Prestonville Bridge Co. has been organized to build a $60,000 bridge over the Kentucky river. Correspondence from bridge builders is invited. Address J. E. GEIER.——Paducah. The Paducah & Illinois Bridge Co. is to be incorporated to build a bridge over the Ohio. S. R. BULLOCK, of New York, is interested.

South Carolina.—The Charleston & Savannah Ry. Co. is putting in iron bridges along its road. Address J. W. CRAIG, Roadmaster, Charleston, S. C.

Illinois.—Murphysboro. A combination bridge over the Big Muddy river has been put in by M. S. Carter & Co., of St. Louis, Mo., for the St. Louis, Alton & Terre Haute R. R.——Cairo. Work is progressing on the Illinois Central R. R. bridge, although the high water has interrupted work on the river piers. The piers are expected to be ready for the superstructure by summer.

Missouri.—Missouri City. The Chicago, Kansas City & Omaha Bridge Co. has been incorporated at Topeka, Kan., by A. BEATON and A. WILLIAMS, of Topeka; P. L. SPOONER, of Madison, Wis., and others, to build a bridge over the Missouri at this place. Capital stock, $800,000. It will be a railway, wagon and foot bridge, and is reported to be in the interest of the Chicago, Oquawka & Kansas Ry.

Minnesota.—Stillwater. The 200-ft. span of the wooden bridge across the St. Croix will be rebuilt by A. Y. Bayne & Co., of Minneapolis, for $990; extra lumber $25 per 1,000 ft. B. M.; extra iron 4½ cts. per lb.——St. Paul. City Engineer RUNDLETT has reported that the Wabash Street bridge is unsafe and recommends that contracts for rebuilding it be let at once.

Iowa.—Burlington. Senator WILSON'S bill for a railroad, wagon and foot bridge across the Mississippi has passed the Senate.——Council Bluffs. The Missouri river bridge of the Union Pacific Ry. has been opened. There is a wagon track on each side of the railroad tracks.

Oregon.—The Dalles. A bridge across the Columbia river, about 3 miles east of the city, is projected.

California.—Sonoma. An iron bridge is to be erected across Sonoma creek at the western end of the town. The cost will be about $3,500, paid half by the city and half by the county.

Canada.—Smith's Falls, Ont. The Dominion Government is being urged to build a new iron bridge over the Rideau river and canal.

Canals.—*Fayetteville, N. C.*—The city will have surveys made for a water power canal from the Cape Fear river.

Cedar Keys, Fla.—A ship canal is projected from the St. John's river to Cedar Keys. Address JOHN F. DONALL.

Sault Ste. Marie Canal.—The survey of this Canadian canal is progressing. The cross-section work is nearly completed. Proposals will soon be advertised.

An Inter-Lake Canal.—It is reported that New York and Minneapolis capitalists have revived the project for a canal between Big Bay de Noc, Lake Michigan and South Bay, Lake Superior, a distance of 40 miles. A survey is to be made shortly. The distance would be reduced by one day and the dangerous passages of the "Soo" and the Straits of Mackinac would be avoided. The estimated cost is $5,000,000.

RAILROADS

East of Chicago.

Existing Roads

Lehigh Valley.—Chief Engineer A. W. STEDMAN reports the following tracklaying during 1887: Luzerne to Harvey Lake, 12⅞ miles; Delano to Hazelton 13 miles; Highland to Sandy Run Junction 2½ miles.

Bells' Gap and Clearfield & Jefferson.—For the following record of extensions built in 1887, we are indebted to Mr. ROBT. G. FORD, General Superintendent: From Mahaffey to Horatio, Jefferson County, Pa., 21½ miles; Irvona to Frankhurst, 2 miles; Irvona to Witmer Land Co's mill, ⅝ miles; branch to Mine ⅞ miles.

Cleveland & Canton.—A circular has been issued stating that the company has obtained an option on the $600,000 of bonds of the Coshocton & Southern Railroad which is to be built from Coshocton, the southern terminus of the Cleveland & Canton, to Zanesville, O., about 30 miles, under which the exclusive right of subscribing for these bonds is offered to the Cleveland & Canton stockholders. There is no doubt that that the bonds will be taken, and the new road built at an early date. President BLOOD will also soon bring about a reorganization of the Columbus & Eastern company.

New York, Rutland & Montreal.—This perennially unfortunate road—the old Lebanon Springs line—extending from Bennington, Vt., to Chatham, N. Y., 57 miles, has been abandoned, no trains having run over the road since Tuesday, Feb. 14. The road

is burdened with litigation and has not been able to meet its fixed charges for some time. It is probable that the Housatonic company will secure control of the road and will complete the partly graded extension of ten miles from State Line to Lebanon Springs this season. This would give the Housatonic a through line from Bridgeport, Ct., to Bennington, Vt.

Williamstown & Delaware River.—

MULLICA HILL, N. J., Feb. 16, 1888.

EDITOR ENGINEERING NEWS:

Grading on the extension from Glassboro to Mullica Hill, N. J., is in progress and is about three-fourths completed. The track is expected to be laid by May, 1888.

F. H. THOMAS, *Contractor.*

Toledo & Ohio Central.—The Buckingham branch 11 miles in length which has been recently leased is to be thoroughly repaired.—The earnings for the first week in February were $24,425, an increase over the corresponding week in 1886 of $3,113.

Louisville, Evansville & St. Louis.—The company is to spend about $150,000 this season on a depot and terminals at New Albany, Ind.

South Pennsylvania.—The fight in the courts over the building of this road is to be taken up with renewed vigor by the Pennsylvania Railroad's attorneys now that the syndicate have announced their purpose of completing the road. Some indefinite rumors are in circulation concerning a hitch in the syndicate's plans, but they lack confirmation. Many look upon the affair as likely to lead to a war between the Pennsylvania and New York Central systems. The South Penn. is said to have been projected by the Vanderbilts to pay off the Pennsylvania for its frendliness to the West Shore enterprise, and it is said to have been one of the conditions of the treaty of peace made by the trunk lines in 1885, that the South Penn. should not be finished.

Canadian Pacific.—A surveying party is at work on a line from Cooksville, Ont., to Hamilton. It is expected to construct a short line to Toronto the present season along the Don river. A bridge will be required 1,200 ft. long, and 65 ft. high; otherwise the work on the line is light.

Michigan Midland & Canada.—A correspondent informs us that there is a probability that this road will be extended soon from Lenox westward to Oxford on the Detroit, Bay City & Alpena R. R., about 26 miles.

New Projects and Surveys.

Zanesville, Newcomerstown & Cleveland.—

ZANESVILLE, Ohio, Feb. 20, 1888.

EDITOR ENGINEERING NEWS:

I have mailed to you to-day a copy of our prospectus. We have traffic contracts with the Baltimore & Ohio and the Valley R. R. Companies, and also a 10 per cent. traffic guarantee from the latter company, and our road is, therefore, part of a through line from Cincinnati *via* this city to Cleveland. We expect to have our road under contract by May 1, next.

EDMUND TURNER, *Manager.*

The Prospectus sent us is a neat pamphlet of 31 pages and gives what seems to be a fair and honest account of the prospects of the proposed line. The report of General Manager and Chief Engineer TURNER states that he has made the location and estimates for constructing the proposed line from Zanesville to Mineral City, a distance of 72¼ miles. The work has been done on the following basis: Max. grades 66 ft. per mile. Max. curves 6°. Truss bridges of steel. Rails 60 lbs. with angle plate joint fastenings. The estimate of cost per mile is as follows:

Road-bed	$ 8,475.34
Track superstructure	6,757.65
Building equipments	1,062.56
Rolling stock	2,923.08
Engineering and general expenses	515.74
Total per mile	19,724.34
Total 72¼ miles	$1,430,014.65

The report states that three fourths of the right of way has been granted and the remainder will probably be given soon. A description is given of each principal town upon the line, with population and the character of its industries, and statistics of the valuation and products of the region which the road will penetrate There is also a statement of the large mineral resources which will be developed, confirmed by a report made to the company by J. L. MORRIS, Mine Inspector for the Second District of Ohio.— Altogether the company seem to push their enterprise in a legitimate, candid and business like manner, and if their statements hold good, they should find no difficulty in obtaining the funds to build their line.

Detroit & St. Clair River:—

ST. CLAIR, Mich., Feb. 17, 1888.

EDITOR ENGINEERING NEWS:

Our line is projected to connect the Canada Southern and Michigan Central Railways. It has been surveyed and will be about 43 miles in length. The right of way is now being secured. Two swing bridges will be required. One at Marine City and one at Mt. Clemens.

C. MCELROY, *President.*

Binghamton & Williamsport.—This company has filed its charter in Pennsylvania locating its general offices at Williamsport and describing its proposed line as surveyed from that city to Binghamton, N. Y., about 90 miles. JOS. P. NOYES, of Binghamton, N. Y., is President. The route of the line may be found by reference to our Map No. 3, published Oct. 8, 1887. It seems probable that contracts for the line will be let this spring.

Vincennes, Oakland City & Owensboro.—The officers of this company have filed a charter for the Owensboro & Indiana Bridge Company to build a bridge across the Ohio river from Owensboro, Ky. The surveys for the bridge will be made as soon as the weather permits. JAS. C. RUDD of Owensboro is President.

Worcester & Hudson.—

WORCESTER, MASS., Feb. 22, 1888

EDITOR ENGINEERING NEWS:

Nothing has been done lately on the Worcester & Hudson R. R. It is now expedient to change the name and organize a new company to be called Boston, Worcester, Hartford & New York and build a line from Boston to Worcester, 42½ miles, and from Worcester to Hartford, 62 miles, making a line 18 miles shorter than the Boston & Albany.

JOHN GILMAN, *President and General Manager.*

Karshner, Washington & Chicago.—A committee is working up the right of way for this projected road in the Hocking coal region of Ohio. FRANK JOHNSON, Washington C. H., Ohio, is interested.

Baltimore & Eastern Shore.—The South River Terminal Company has been incorporated in Maryland to build a railroad from a connection with the Annapolis & Baltimore Short Line Railroad at or near Annapolis, to Thomas' Point, at the mouth of South river, 4½ miles. This is to be the terminus of the Baltimore & Eastern Shore road on the western side of Chesapeake Bay. The company is making good progress in obtaining aid from the counties interested.

Toledo & Indianapolis.—J. H. SHINN of Willshire, O., writes us that this rumored project mentioned in a recent issue is, in brief, to use the Toledo, St. Louis & Kansas City R. R., from Toledo to Willshire, O., and from that point to build a new road to Indianapolis about 100 miles. The line is to run *via* Salem, Berne, Buena Vista, Nottingham, Hartford City, Wheeling Gilman and Anderson.

Wheeling & Harrisburgh.—The city of Wheeling W. Va., has voted to subscribe $300,000 to the capital stock of this company which is to bridge the Ohio at Wheeling, build terminals and a Union passenger depot in that city, and the 40 mile extension of the Wheeling & Lake Erie R.R. from Bowerston to Wheeling. HEMAN CLARK, the New York Aqueduct contractor, is interested in the enterprise.

SOUTHERN.

Existing Roads.

South Atlantic & Ohio.—Track was laid on this road in western Virginia in 1887, from Mendota to Big Cut, 40 miles. The line has been graded from Big Cut to the Clinch river, 10 miles, and has been located to Big Stone Gap, 25 miles farther, making the total length of the line when completed from Bristol to Big Stone Gap, 75 miles. The general offices are at Bristol, Tenn.

Norfolk & Western.—

ROANOKE, Va., Feb. 8, 1888.

EDITOR ENGINEERING NEWS:

Please find below mileage of track laid during 1887.

Extension.	*Miles.*
Cripple Creek, Foster Falls to Ivanhoe	8.03
Hematite Branch, Hematite Junction to Mines of Hematite Iron Co.	0.77
Little Reed Island Branch, Little Reed Junction to Patterson	5.11
Perrywinkle Branch, Patterson to Mines of Reed Island Iron Co.	0.36
Flat Top, Simmons to end of Track	3.97
West Fork of Mill Creek, West Fork of Mill Creek Junction to Mines of Jno. Cooper & Co.	0.25
Simmons Creek Branch, Simmons Creek Junction to Mines of Simmons Creek Coal & Coke Co.	0.12
Flipping Creek Branch of Flat Top Extension, Initial Point of Flipping Creek Branch to end of track	3.19
East Branch of Flipping Creek, from East Fork of Flipping Creek Junction to Mines of R. Goodwill & Co.	0.89
Clinch Valley Division, Graham, Va., to end of track	3.84

CHAS. C. WENTWORTH, *Prin. Asst. Engineer.*

The above furnishes an excellent showing of the remarkable development of the mineral resources of western Virginia, and can hardly fail to result in a great permanent increase of traffic on the Norfolk & Western system.

Georgia Pacific.—"Whether or not the new South is at a standstill, whether or not the Southern iron-making towns are losing life, and whether or not Southern railroads are prospering, can be pretty well determined by the January statement of the Georgia Pacific Railroad, which shows that at one station of Birmingham, Ala., 993 carloads of freight were handled during January, 1887, while this year the number of carloads rose to 1,676.—*N. Y. Times.*

Florida Railway & Navigation Co.—The western division of this road has been sold to W. B. CUTTING, representing the bondholders' interests. The remainder of the system will be sold on the first Monday in April and the company will be reorganized and a new bond issue will be made at the rate of $5,000 per mile bearing 5 per cent. interest. On account of the present low traffic rates which are in force in Florida by law, the company will not attempt to invest any considerable amount in permanent improvements or extensions.

Atlanta & Florida.—The track is now laid from Atlanta to the Flint river, 35 miles, and the managers state that they expect to reach Fort Valley, 100 miles from Atlanta, by May 1. From that point they hope to push on to Hawkinsville, Thomasville and Tallahassee. The company has three engines, forty freight cars and three passenger cars. The cost of grading the first 32 miles from Atlanta is said to have been about $2,000 per mile.

Tavares, Apopka & Gulf.—

TAVARES, FLA., Feb. 10, 1888.

EDITOR ENGINEERING NEWS:

Track was laid on the extension of the Tavares, Apopka & Gulf road in 1887, from Astatula, Fla., to Minneola, 19 miles.

W. B. TUCKER, *General Manager.*

Alabama, Florida & Atlantic.—This Florida road, on which 22 miles were graded last year from Eustis to Altamonte, seems to have come to grief, as we notice that it is advertised for sale, including the old Apopka & Atlantic, 5 miles in length and all the company's lands, tenements, rights of way, rolling stock, franchises and other properties too numerous to mention. The sale was made at the instance of the firm of L. O. GARRET & BRO. According to present indications, this mammoth 500-mile project is to meet a common fate of 500 mile projects, and be nipped in the bud by the lack of sympathy and the cold utilitarianism of the contractors for grading.

Montgomery & Florida.—General STEWART L. WOODFORD who represents the bondholders' interests, is reported by the Montgomery *Advertiser* as saying that as soon as the receivership can be terminated the bondholders are ready and willing to build the extension south.

Georgia Pacific.—The following statement of track-laying in 1887 is sent us from the Chief Engineer's office: Coalburg to Cane Creek, 39.4 miles; Woodlawn to Bessemer, 18.75 miles.

East Tennessee, Virginia & Georgia.—Surveys are in progress for a line from Maplesville, Ala., to Montgomery, about 40 miles, under direction of Col. CAREY A. WILSON, Chief Engineer of the Mobile & Birmingham R. R.

Central Railroad of Georgia.—The headings have meet in the Oak mountain tunnel on the Columbus & Western extension to Birmingham. The Coosa tunnel is making rapid progress and it is expected that it will be "holed" by March 1.

Covington & Macon.—The contractors who were left in the lurch when the company fell into financial straits some time ago, have received their pay and are correspondingly happy. Work is to be pushed on the extension to Athens and the line will probably reach there early in summer.

Cincinnati, New Orleans & Texas Pacific.—This company, which leases the Cincinnati Southern R. R., has issued its report for 1887. The year has been a very prosperous one for the company because of the great increase in the traffic receipts. The following is a condensed statement:

GROSS EARNINGS.

	1886.	1887.
Passengers	$ 623,463	$ 740,617
Freight	2,130,765	2,493,039
Mail service	58,903	63,693
Express service	43,654	55,530
Miscellaneous sources	24,384	24,669
Totals	$2,882,171	$3,377,551

OPERATING EXPENSES.

	1886.	1887.
Conducting transportation	$ 635,293	$ 694,789
Motive power	454,017	498,837
Maintenance of cars	159,455	209,829
Maintenance of way	340,720	453,467
General expenses	173,392	178,648
Totals	$1,753,879	$2,034,572
Net earnings for the year	$1,128,292	$1,342,979

For the year operating expenses were 60.86 per cent of the gross earnings. In comparison with the preceding year, the gross earnings show an increase of $495,380 or 17.19 per cent. Operating expenses, an increase of $280,693 or 16 per cent. Net earnings, an increase of $214,686 or 19.03 per cent.

The revenue per ton of freight transported was $1.72 against $1.79 the preceding year, a decrease of .07 per cent. per ton, or 3.91 per cent. The revenue per passenger carried was $1.19 against $1.10 the preceding year, an increase of .09 per cent. per passenger, or 8.18 per cent.

The shops of the company destroyed by fire at Ludlow, will have to be rebuilt during the coming year in a substantial manner. Besides these the following expenditures will be required in 1888:

For work on tunnels	$ 40,000.00
For additional side-tracks, including cost of grading	40,000.00
For replacement of bridges	20,000.00
For filling trestles	20,000.00
For fencing	10,000.00
For buildings and coal chutes	20,000.00
For motive power	150,000.00
For rolling stock	20,000.00

Martinsburgh & Potomac.—This leased line of the Cumberland Valley Ry. Co., has been sold at foreclosure sale. The company is to be reorganized, and it is stated that the extension to Winchester, Va., which has long been under consideration, is likely to be made at an early date.

Blue Ridge & Atlantic.—The Tallulah Falls division of the Northeastern R. R. of Georgia has finally been turned over to W. B. THOMAS, and is to be known by the above name. Mr. THOMAS is the President and General Manager, with office at Tallulah Falls, Ga. This is the road which it is desired to extend to Knoxville, Tenn.

Cincinnati, Selma & Mobile—Surveys have been made for the extension from Hamburgh to Selma, Ala., the cost is estimated at $135,000.

Oxford & Clarksville—The contract for this road has been let to L. Wright & Co., and A. & C. Wright. The distance to be built is about 32 miles, from Oxford to Durham, N. C. The line is to be completed by Aug. 1.

Chesapeake & Ohio.—The reorganization of this company is making good progress under Drexel, Morgan & Co.'s management and a large portion of the security holders have already given assent to the plan. There is however some opposition to the plan among bondholders who believe the bankrupting of the company was not at all necessary under proper and efficient management and that the underlying reason for the financial straits into which the company has been driven is the desire of C. P. HUNTINGTON and a few of his interested friends to open the way by which a still larger proportion of the company's earnings may find its way to their own pockets. Mr. WILLIAM STRAUSS is the leader of the opposition and there is some prospect that there will be an interesting fight over the attempt to scale down the existing securities. The opposition party propose to stir up the Virginia Legislature to an investigation of the methods by which the stock of this company has been rendered valueless, and the State of Virginia has lost a million dollars or so. Such an attempt was recently made in the Senate at Richmond, but Receiver W. C. WICKHAM, who is one of the Senators, rose in his place and stated that if the Senator who had presented the resolution dared to insinuate that he (WICKHAM), had been guilty of any dishonesty in his management of the road, he would place him "where the hand of God could not reach him." This fiery speech killed the resolution.

New Projects and Surveys.

Nashville & Charleston.—

KNOXVILLE, Tenn., Feb. 13, 1888.

EDITOR ENGINEERING NEWS:

The Nashville & Charleston Railway is projected to run from Nashville, Tenn., to Charleston, S. C., a distance of 599 miles. The proposed route crosses the Tennessee coal field *via* Crossville and Crab Orchard Gap; intersects the Cincinnati Southern R.R. below Rockwood, Tenn.; the East Tenn., Va., & Ga. R.R., near Sweetwater, Tenn., and the Western North Carolina R.R., at Bushnell in North Carolina. It follows the little Tennessee river through the Great Smoky or Unaka Mountains to the summit of the Blue Ridge, at Rabun Gap, in Georgia, thence descends into the Piedmont Region at Walhalla, S. C., and runs near Anderson, Abbeville, Edgefield, Aiken, Barnwell, and Walterboro in South Carolina to the city of Charleston.

It is designed to form part of a trunk line from the South Atlantic seaboard to the West and Northwest, and to develop the coal, iron, marble, timber, and other extensive native resources of Tennessee, North Carolina, Georgia and South Carolina. Preliminary surveys were made in 1887 from Nashville, Tenn., to Walhalla, S. C. A division of 75.7 miles from the E. T. V. & G. R.R. to the Western North Carolina R.R., is now under location, and will soon be let to contractors. The heaviest grade shown by preliminary survey is 1½ per cent., and it is under consideration to reduce this to one per cent. by using single pusher grades on the mountain sections. Dr. W. L. BREYFOGLE, of Louisville, Ky., is President.

WILLIAM H. CASE, *Chief Engineer.*

Bowling Green & Northern.—A mass meeting was recently held at Bowling Green, Ky., to consider the question of building a railroad from Bowling Green to the Ohio river. Resolutions were adopted requesting the county's representatives in the legislature to secure amendments to an existing charter which will permit the county to vote $200,000 aid to the project.

Kingston & Emory Gap.—

NEWBERN, Pulaski, Co., Virginia, Feb. 20, 1888.

EDITOR ENGINEERING NEWS:

I have entered into an arrangement with the principal citizens of Kingston, Tenn., to raise the required capital for construction and equipment of the Kingston & Emory Gap Railway. This railway will be about 7 miles long, connecting the town of Kingston with the main line of the Cincinnati Southern Ry., at Emory Gap depot. The surveys of the road have already been made, and as soon as capital is subscribed or advanced it is intended to commence work on the road. Large quantities of Iron ore, Coal and other Minerals and Merchandise await the completion of the road, which it is believed will pay handsome dividends from its first opening. Have you any parties who are willing to invest in such enterprises as this railway? If so I shall be glad to hear of them or from them.

EDWARD SHELLEY.

THE NORTHWEST.

Existing Roads.

St. Paul, Minneapolis & Manitoba.—The Eastern Minnesota R. R. Co., which is to build the line from Hinckley, Minn., to Superior, 70 miles, has let the contract for the construction to Foley Bros., of St. Cloud.

Atchison, Topeka & Santa Fé.—Surveyors are at work on a line to connect with the Toledo, Peoria & Western. It is reported that the company will secure an entrance to Keokuk, Ia., over the Keokuk & Northwestern road, and has abandoned the projected Keokuk & Santa Fé line from New Boston to Keokuk.

St. Louis, Alton & Springfield.—The 12 mile extension which has been located to Alton, Ill., is to be built as soon as spring opens.

St. Paul & Duluth.—The company has publicly acknowledged its intention of building from St. Paul to Omaha by the incorporation of the Duluth, Twin Cities & Southwestern Railroad Company. Right of way has been asked from Faribault and Waseca, and it seems that the company has not made its preliminary surveys for nothing, but means to go ahead with the extension at once.

Red River Valley.—Premier GREENWAY states that he has received an offer from a responsible firm for the completion of the Red River Valley road, and while the Government is not obliged to accept it if a better offer is made, the present offer is an easy one for the Province financially, and ensures the building of the road.—Ryan & Haney, the contractors who graded the road last summer have been awarded $58,804 by the arbitrators. Their claim was about $146,000.

Chicago, Burlington & Quincy.—The annual report for 1887 makes the following showing:

Gross earnings	$27,567,078
Operating expenses	16,097,913
Net earnings	$12,337,219

This amount has been distributed as follows:

Fixed charges	$5,286,084
Dividends	6,111,064
Surplus	940,971

M. J. FITZGERALD has the contract for the line from Ashland to Nebraska City, Neb., 35 miles. The line is to be finished within four months.

Duluth, South Shore & Atlantic.—A later report from Chief Engineer J. A. LATCHA corrects the statement furnished us recently of tracklaying in 1887, and gives the mileage as follows: Soo Junction to Sault Ste. Marie, 46¾ miles; Nestoria to a point 12 miles west of Dogwood, Mich., 125 miles. This corresponds closely with our summary published with the Northwestern Map in the issue of Jan. 28.

Chicago & Eastern Illinois.—Chief Engineer S. H. MILLER corrects our statement of tracklaying in 1887. The mileage laid was from Sidell to Tuscola, Ill., 27 miles. The 23 miles from Danville to Sidell was laid in 1881.

New Projects and Surveys.

Chippewa Falls & Ashland.—L. J. RUSK, of Chippewa Falls, acting Secretary of this Wisconsin company, sends us a map of the proposed road running north to Ashland, 130 miles, and states that right-of-way is being secured. Hon. THAD. C. POUND, is President. Advices from other sources indicate that the promoters of this line are likely to let contracts this spring.

Yankton & Southwestern.—This company has been incorporated with headquarters at Norfolk, Neb., to build a road from Yankton to the Kansas State line. The incorporators are HENRY B. LOW, of Middletown, N. Y., President of the Port Jervis, Monticello & New York R.R., and other directors of the same company.

Duluth, St. Cloud, Mankato & Southern.—At the annual meeting of this Minnesota company, JOHN COOPER, of St. Cloud was elected President, D. K. SMITH, of Austin, Vice-President, H. H. CORSON, of New Richmond, Treasurer, and GEO. T. BARR, of Mankato, Secretary. The company hopes to begin surveys this spring.

Lincoln, Red Oak & Des Moines.—This Nebraska company has sent out a party to make a preliminary survey.

THE SOUTHWEST.

Existing Roads.

Kansas City & Southern.

308 *Rialto Building.*

KANSAS CITY, Mo., Feb. 10, 1888.

EDITOR ENGINEERING NEWS:

The Kansas City & Southern Railroad is under construction from Kansas City to East Lynn, Mo., about 48 miles, and a branch chartered as the Kansas City & Southeastern is under construction from Kansas City to Hart's Grove, 11 miles. There is but a short distance of track laid on the above roads, but thirty miles are ready for track, and the whole will be completed in June next. Schnellbacker & Gilman, of Kansas City, are the principal contractors. JOHN I. BLAIR, of New Jersey, is the builder of the road.

B. R. WHITNEY, *Chief Engineer.*

Chicago, Rock Island & Pacific.—A press report which has been widely circulated, states that the company proposes to issue bonds for $30,000,000 and build 1,200 miles of extensions this year, to Denver and the Gulf of Mexico. The company states that the Colorado extension will be pushed through at once, but while it is the ultimate intention to reach the Gulf and the Pacific Coast, it is not likely that the work will be done faster than business justifies it. A number of surveying parties are working on lines from Wichita Falls, Tex., southwest in the interest of local companies formed to aid the Rock Island extension. If these local companies can offer large enough inducements, it is possible that the Rock Island may build a considerable mileage in Texas this year.

Quincy, Omaha & Kansas City.—This is the new name of the reorganized Quincy, Missouri & Pacific. C. H. BULL is President, AMOS GREEN is Vice-President and General Manager.

Missouri Pacific.—Work is to be resumed soon on the Taylor, Bastrop & Houston road in Texas. Contracts have been let for a $35,000 Union passenger depot at Austin, Tex.

East Louisiana.—The tracklayers on this road have reached Claiborne, La.

Houston & Texas Central.—The reorganization of this Texas Company is making good progress. Sixty per cent. of the bondholders have assented to the plan of reorganization. A considerable number of first mortgage bondholders, however, headed by Mrs. HETTY GREEN, are making an obstinate fight to the proposition to scale down the interest on their bonds from 7 to 5 per cent. Mrs. GREEN is determined to insist on her rights and it is quite likely that there will be a sharp fight over the reorganization.

Waco & Brazos Valley.—This company recently formed at Waco, Tex., has secured the subsidy which was offered to the San Antonio & Aransas Pass company. This makes the whole amount of stock taken about $150,000. The chartered line is 65 miles in length and is now being surveyed. WM. CAMERON is President and J. H. FITKS, Secretary.

Montana, Kansas & Texas.—It is reported that President A. L. TOMBLIN is engaged in pushing right-of-way measures through Congress giving his proposed "Cattle Trail Route" a passage through no Man's Land and Indian Territory.

Kansas City & Sabine Pass.—At the recent meeting the bonded indebtedness of the company was increased to $3,000,000 and the capital stock to the same sum. The contract for building the line from Kansas City to Pierce City, 117 miles, has been let to the Kansas City & Sabine Pass Construction Co. The line runs *via* Belton, West Line, Ellis and Lamar.

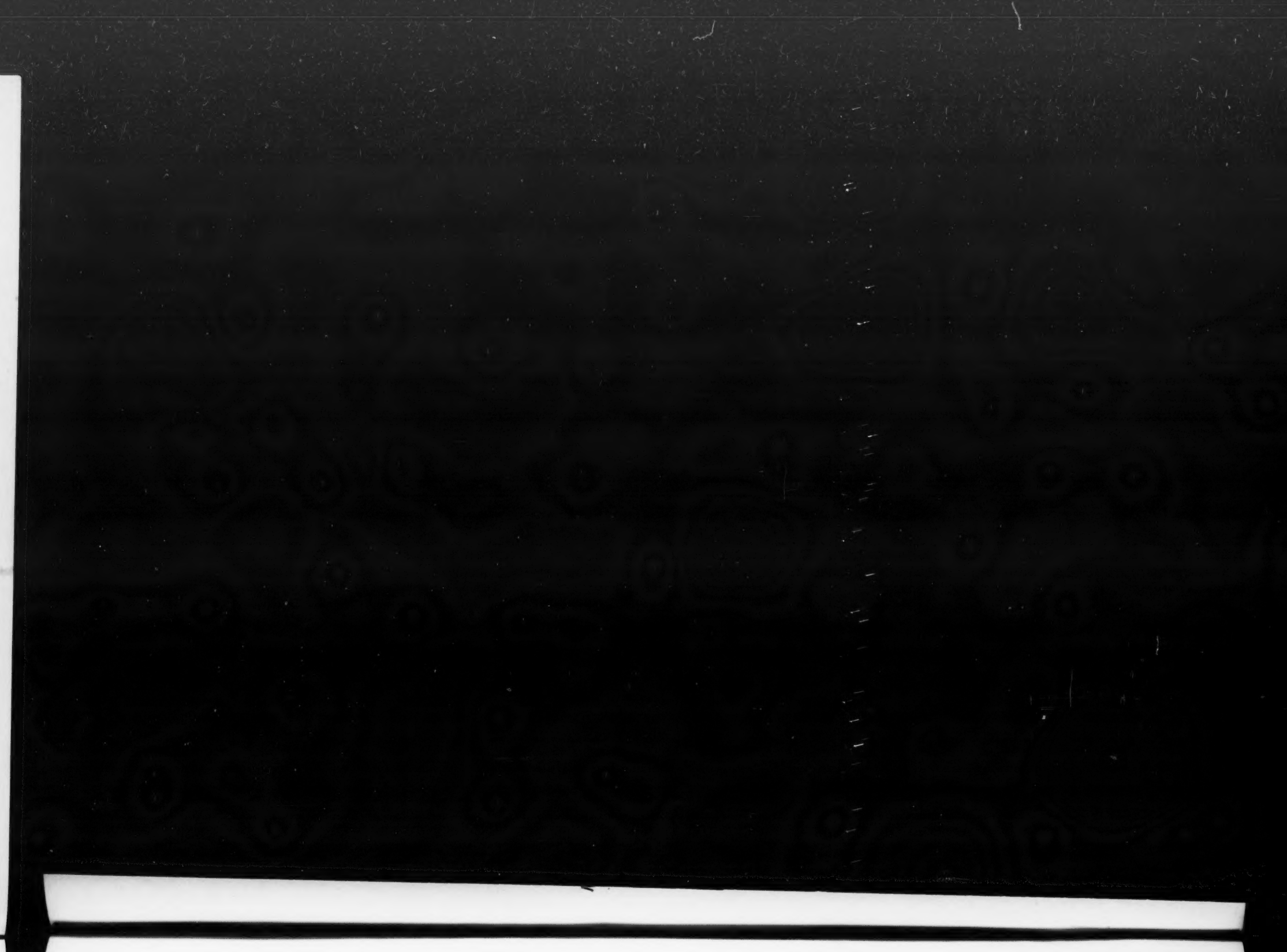
Gainesville & Southwestern.—This company is to be organized at Gainesville, Tex., to build a line from Gainesville to Decatur and thence Southwest. A preliminary survey has been made by L. J. CASWELL. The company intends to grade the road and induce the Santa Fé, Missouri Pacific, or Fort Worth & Denver to complete the line.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Chicago, Rock Island & Pacific.—The Denver Chamber of Commerce appointed a representative to obtain from President R. R. CABLE on his recent visit to that city, a definite statement of the plans and purposes of the Rock Island Company in Colorado. Mr. CABLE said in substance that it was not yet decided whether an independent line would be built to Denver or a traffic arrangement would be made with the Denver & Rio Grande system. The immediate object in building to Colorado was to secure coal, but in time the company would build to Salt Lake through a pass north of the Divide.

The rumored alliance of the Rock Island with the Colorado Midland is said to be unfounded, but it seems to be now practically settled that the extension of 300 miles now under survey from Norton, Kan., to Colorado Springs will be pushed through without delay and will give a direct eastern outlet to the Midland.

St. Paul, Minneapolis & Manitoba.—Not much is heard at present of the Pacific coast extension from Montana. It is reported, however, that a large amount of work will be done in building branches to the Montana mining camps and that 55,000 tons of steel rails have been bought for this purpose.

Union Pacific.—The report is again in circulation that surveys are to be made at once for the extension of the Utah Southern to Los Angeles. It is quite certain however, that the Union Pacific managers will not build any very large extension until some definite understanding is arrived at regarding the company's relation to the Government.